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ASTM BULLETIN

Published by
AMERICAN SOCIETY for
TESTING MATERIALS

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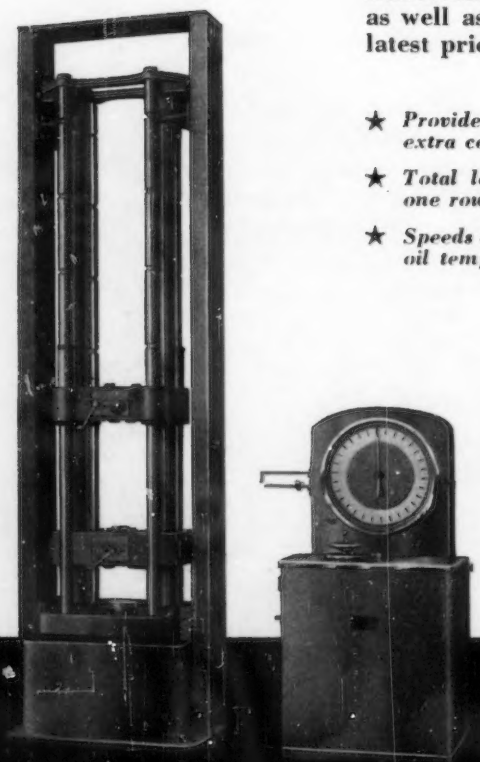

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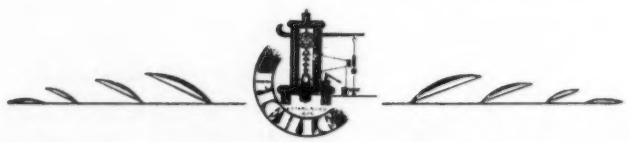

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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering and Standardization of Specifications and Methods of Testing"

TELEPHONE—PENnypacker 3545 CABLE ADDRESS—TESTING

Number 103 March, 1940

Strong and Varied Technical Program Developing for Forty-third Annual Meeting in Atlantic City, June 24-28, 1940

Several Symposiums and Special Technical Sessions Being Organized

WHAT PROMISES to be one of the strongest technical programs featuring an annual meeting is rapidly rounding into shape for the Forty-third Annual Meeting to be held at Chalfonte-Haddon Hall, Atlantic City, June 24 to 28, 1940. Several symposiums and technical sessions relating to specific subjects are being organized under the direction of Committee E-6 on Papers and Publications. Special groups, or in some cases standing committees, are responsible for developing groups of papers and handling details of the symposiums and particular sessions.

There will be no apparatus exhibit at the meeting this year, but as indicated in another portion of this BULLETIN the Third Photographic Exhibit and Competition will be held. This is being developed by a special committee headed by J. P. Mudd, The Midvale Co., an outstanding authority in the photographic field. Associated with him on the committee are other prominent amateur photographers in the Philadelphia area.

In returning to Atlantic City for this year's meeting after the successful 1939 meeting held there, the Executive Committee has had in mind from the beginning the probability that the meeting in 1941 with which would be held the next Exhibit of Testing Apparatus and Related Equipment should be in an inland industrial center. Decision has been reached to meet in Chicago in 1941 probably during the week of June 23, although the exact week has not yet been decided upon.

SYMPOSIUMS; SPECIAL SESSIONS

Subjects which will be covered in formal symposiums at the meeting include: the tension test, tools of analytical chemistry, problems in the classification of natural waters intended for industrial use, and spectrochemical analysis. There will of course be a number of other sessions of interest to specific groups concerned with various aspects in the field of metals, cement, concrete, and mortars and other subjects related to the Society's fields of work.

Symposium on Tension Testing

This symposium, as announced in the January BULLETIN, is the first of several technical discussions on the general subject of "Significance of Mechanical Properties of Metals" being arranged by a joint committee headed by Prof. J. M. Lessells, Massachusetts Institute of Technology, with the cooperation of the A.S.M.E. Applied Mechanics Division and American Institute of Physics. The committee in charge has felt that in view of the great interest in this subject, it would be desirable to publish well in advance of the meeting a general foreword which has been prepared by Professor Lessells. This foreword appears in this BULLETIN and will give a conception of the basic purposes the committee has in mind. Three technical authorities—C. W. MacGregor, Massachusetts Institute of Technology; F. B. Seely, University of Illinois; and H. W. Gillett, Battelle Memorial Institute—are preparing the papers forming the basis of discussion.

Symposium on Tools of Analytical Chemistry

This technical feature is being arranged under the joint auspices of the Division of Physical and Inorganic Chemistry of the American Chemical Society and A.S.T.M., with Dr. G. Frederick Smith, Professor of Chemistry, University of Illinois, acting as chairman of the Symposium Committee and cooperating closely with Dr. G. E. F. Lundell, Chief, Chemistry Division, National Bureau of Standards, vice-president of the Society and Chairman of Committee E-3 on Chemical Analysis of Metals. Specific details of this symposium have not yet been announced, but particular subjects to be covered will include the following: volumetric methods and amperometric titrations; electronic circuits applied to analytical chemical procedures; theory and practice in the control of pH using the glass electrode; microchemistry as a tool in analytical procedures; the applications of organic reagents to analysis; and cerate oxidimetry. It is of interest that this is the first formal technical session that has been jointly sponsored by A.S.T.M. and the American Chemical Society.

Symposium on Spectrochemical Analysis

This subject, of distinct concern to many of those who will be interested in the Symposium on Tools of Analytical Chemistry, will comprise two sessions: the first, accuracy requirements *versus* reproducibility possibilities; second, presentation and interpretation of results. Prominent

authorities will open each session following which there will be an open discussion period. T. A. Wright, Technical Director and Secretary, Lucius Pitkin, Inc., is handling many of the details for this annual meeting feature, working closely with other officers of Committee E-2 on Spectrographic Analysis and tying in with the analytical chemistry symposium.

Symposium on Problems in the Classification of Natural Waters Intended for Industrial Use

It is expected there will be five technical papers in this symposium which is being developed under the auspices of Committee D-19 on Water for Industrial Uses, the chairman of which is Max Hecht, Adviser, Power Stations Chemistry, Pittsburgh. Problems of reporting the results of water analysis will be covered; there will be given a review of the data on the relation of corrosivity of water to its chemical analysis; measuring the scale-forming and corrosive tendencies of water by short-time tests, and related subjects. It is planned that a general introduction to the symposium will be developed by an authority in this field.

Anodic Coatings

Four technical papers bearing on the work of Committee B-7 on Light Metals and Alloys, Cast and Wrought, have been arranged to cover such topics as coatings seen through the microscope, thickness of oxide coatings on aluminum, abrasion resistance, and electrical breakdown.

Radiography

A series of papers is being developed by Committee E-7 on Radiographic Testing under the chairmanship of Dr. H. H. Lester, Watertown Arsenal—further details of this session will be published in the Provisional Program for the meeting to appear in the May BULLETIN.

Metals

Until definite sessions of the remainder of the meeting are developed, it is not possible to point to other specific groups of papers, but of the some 25 offers in the metals field made to Committee E-6 quite a number have been accepted and will appear in the program. Some of the topics involve coupon tests of commercial structural steels, creep of low-alloy steels, atmospheric durability of steels, properties of gray cast iron, effect of protective coatings on corrosion-fatigue strength, fatigue of porous metals, testing lead cable sheathing and fracture tests of cable sheathing under steady tensile load, tension tests on copper alloys, speed of testing results, and others.

Cement, Concrete, Mortars, etc.

Of the large number of papers offered in these fields it is probable those accepted will cover some of the following subjects: Comparison of mechanical and optical methods for size analysis of cement, theory of concrete creep, effect of grading of aggregates on properties of concrete, measuring changes in physical properties of materials by the dynamic method, relation of water absorption and strength to resistance of brick to a laboratory abrasion test and measurements of power factor and dielectric constant of glass.

Plastics, Testing, General Subjects

Other papers definitely scheduled for the meeting cover a number of important materials subjects including accelerated weathering of transparent plastics and the absorption of water by plastics, factors influencing cold flow properties of plastics materials, measuring the plasticity of molding compounds. The program will probably include also discussion on creep phenomenon in ropes and cords, evaluation of titanium pigments for use in the paint industry, extraction method for the determination of metals in driers, and others.

PROVISIONAL PROGRAM

The Provisional Program for the meeting with the various items arranged according to sessions will be published in the May BULLETIN, including synopses of each of the items. This program is of particular significance, since it provides members and those concerned with the important subjects to be covered with a well-rounded picture of what the meeting will cover.

In so far as possible, papers and reports will be preprinted. Each member will receive a preprint blank well in advance of the meeting so that he can request advance copies of papers and reports.

HOTEL RESERVATIONS

Early in May there will be sent to each member a blank giving hotel rates at Chalfonte-Haddon Hall with a form which members can use in making reservations for the meeting. Members who wish can at any time send reservations to the hotel, explaining that they will be attending the A.S.T.M. meeting. These should be addressed to the hotel management, Chalfonte-Haddon Hall.

It is expected that a number of the members and their families who will be attending the Fair in New York City this year will plan to combine attendance at the A.S.T.M. meeting and visits to the Fair.

Railroad Reservations.—Even though it may be quite early to think of railroad reservations, members should keep in mind that the National Republican Convention will be held in Philadelphia during the week of the A.S.T.M. meeting in Atlantic City. In view of this, it would be desirable that railroad reservations be made earlier than may have been customary. No special convention rates will be in effect but full information on any special rates that may be available can be obtained from the railroad ticket offices.

1940 Golf Tournament

1940 Exhibit of Photography to be Held During Annual Meeting

THE 1940 A.S.T.M. Exhibit of Photography will be held during the week of the Forty-third Annual Meeting at Chalfonte-Haddon Hall, Atlantic City, June 24 to 28, inclusive. The general theme will involve the field of engineering materials, stressing testing and research, and this year photographs showing unique or unusual applications of materials are especially desired as well as photographs of apparatus, instruments, testing, and related items. Unusual photographs of the commoner applications of engineering materials will also be considered by the committee.

The committee in charge of the photographic exhibit includes the following, all prominent photographers in the Philadelphia District:

J. P. Mudd, *Chairman*, The Midvale Co.
L. Drew Betz, W. H. & L. D. Betz
Frank Chestnut, Ajax Electrothermic Corp
J. P. Eldridge, Leeds & Northrup Co.
Nevin Funk, Philadelphia Electric Co.
T. H. Le Boutillier, Edward G. Budd Manufacturing Co.
Mathew Lynch, Autocar Co.

Messrs. Mudd and Eldridge were members of the committee for the successful 1939 exhibit, Mr. Eldridge having served as chairman last year. This year there will be no section on photomicrography, but as part of the photographic display, Committee E-7 on Radiographic Testing is sponsoring an exhibit portraying a number of advances and developments in its field. The radiographic section is not open for competition, since Committee E-7 is developing special exhibit material. Dr. Victor Hicks, in charge of the radiographic display, is representing Committee E-7 on the photographic committee.

Entry Forms and Rules

An entry form and descriptive folder giving details of the exhibit, including rules, is in preparation and will be mailed to all A.S.T.M. members early in May. Any members of the Society and individuals affiliated with company memberships, etc., can obtain copies of the entry blank in advance by writing A.S.T.M. Headquarters addressing the communication to the 1940 Photographic Committee.

Certificates of Merit will be awarded to first, second, and third places, and for honorable mention. Judging will be on the same basis as in 1939, namely, 70 per cent for portrayal value, 30 per cent for timely interest and importance of subject matter. Photographs must be mounted on 16 by 20 in. white or buff mounts in a vertical position. No written or printed material should appear on the print or front of the mount—the committee will affix in uniform style the title as given by the photographer, the photographer's name and company. Not more than four prints may be submitted by an individual for the consideration of the jury of selection.

Both amateur and professional photographs will be solicited, but the awards for the first three places will be confined to the amateur class. "Amateur" will be construed as applying to any photograph made by an A.S.T.M. member or an employee of a member company whose principal occupation is not photography.

This year the committee will welcome color transparencies if on standard 35-mm. film and mounted between standard 2 by 2-in. glass slides. Every effort will be made to display them properly. Those wishing to exhibit other transparencies must provide their own illuminating devices. Transparencies will not be judged with the other entries.

All entries must be received by June 15, and are to be sent to the Photographic Committee, A.S.T.M. Headquarters, 260 S. Broad Street, Philadelphia, Pa.

"Hardness of Rubber Packing by A.S.T.M. Method"

Awarded honorable mention, amateur class, in the 1939 A.S.T.M. Photographic Exhibit. Submitted by J. B. Flad, Crane Co. Research Laboratory, Chicago, Ill.

Symposium on New Materials in Transportation at Detroit Meeting

THE SYMPOSIUM on New Materials in Transportation, the technical feature of the 1940 Spring Meeting, held in Detroit, on Wednesday, March 6, comprised seven technical papers by prominent authorities in the respective fields. Two sessions were devoted to the symposium—morning and afternoon. The papers covered steels, rubber, road materials, fuels, and lubricants.

General arrangements for the Spring Meeting and A.S.T.M. Committee Week, in progress March 4 to 8, were in the charge of the Detroit District Committee, headed by T. A. Boyd, with C. H. Fellows, *Secretary*.

A list of the committee personnel (which in this instance includes several men not members of the District Committee who were requested to serve in connection with the Detroit arrangements) follows:

T. A. Boyd, *Chairman*, Head Fuel Dept., General Motors Research Laboratories, General Motors Corp.
J. L. McCloud, *Vice-Chairman*, Metallurgical Chemist, Ford Motor Co.
C. H. Fellows, *Secretary*, Head, Chemical Division, Research Dept., The Detroit Edison Co., *Chairman, Banquet Committee*
C. E. Heussner, Materials Engineer, Chrysler Corp., and W. H. Graves, Chief Metallurgist, Packard Motor Car Co., *Co-chairmen, Program Committee*
W. C. Du Comb, President, The W. C. Du Comb Co., Inc., and Martin Castricum, Manager, Textile Section, Product Development Division, United States Rubber Co., *Co-chairmen, Finance-Publicity Committee*
F. P. Zimmerli, Chief Engineer, Barnes-Gibson-Raymond, Division of Associated Spring Corp., *Chairman, Plant Inspection Committee*

Peter Altman, Director, Department of Aeronautics, University of Detroit
Sydney Bevin, Chief Engineer, Fiske Brothers Refining Co. (Toledo, Ohio)
V. M. Darsey, Technical Director, Parker Rust-Proof Co.
S. D. Heron, Research Engineer, Ethyl Gasoline Corp.
A. J. Herzig, Chief Metallurgist, Climax Molybdenum Co. of Michigan, Inc.
J. W. Kennedy, Engineer, Service Bureau, Huron Portland Cement Co.
H. C. Mougey, Technical Director, Research Laboratories, General Motors Corp.
W. P. Putnam, President, Treasurer and Technical Director, The Detroit Testing Laboratory
E. W. Upham, Chief Metallurgist, Chrysler Corp.
J. H. Walker, Engineer Assistant to General Manager, The Detroit Edison Co.
A. E. White, Director of Department of Engineering Research, and Professor of Metallurgical Engineering, University of Michigan

A dinner session featured an address on "The Antiquity of Things New in Transportation" by J. S. Worley, Professor of Transportation Engineering and Curator of the Library of Transportation, University of Michigan. Professor Worley used as the basis of his talk illustrations from many of the books and published works of the nineteenth century, and in several cases, of three or four hundred years ago. Many of these indicated that scientists of these days predicted quite accurately many of the major developments in transportation—streamlining, use of gearing in transmitting power, spring suspension, etc. The illustrations in practically all cases were taken directly from originals in the files at the Transportation Library, which is an outstanding collection in this field.

During the dinner President H. H. Morgan commented on the widespread use of materials in the automotive field, a considerable percentage of total production in some cases being consumed in the automotive industry, and mentioned that this was one of the primary reasons why A.S.T.M. was so interested in the automotive field and why conversely the automotive industry was so active in A.S.T.M. work in standardization and research in materials.

SYMPOSIUM ON NEW MATERIALS IN TRANSPORTATION

The technical papers comprising this symposium are as follows:

Exhaust Valve Materials for Internal Combustion Engines—S. D. Heron, Research Laboratories, Ethyl Gasoline Corp.; O. E. Harder, Assistant Director, and R. M. Nestor, Research Engineer, Battelle Memorial Institute.

Selection and Application of Automotive Steels—A. L. Boegehold, Head, Department of Metallurgy, General Motors Research Laboratories; W. H. Graves, Chief Metallurgist, Packard Motor Car Co.; and E. W. Upham, Chief Metallurgist, Chrysler Corp.

Rubber of Tomorrow—S. M. Cadwell, Director of Tire Development, United States Rubber Co.

Advances in the Uses of Concrete in Transportation—Miles D. Catton, Development Department, Portland Cement Association.

Recent Developments in the Use of Asphalt for Transportation Purposes—Bernard E. Gray, In Charge of Department of Highway Engineering, The Asphalt Institute.

Trends in the Properties of Volatile Liquid Fuels—D. P. Barnard, Assistant Director, Research Laboratories, and A. H. Fox, Research Assistant, Standard Oil Co. (Indiana).

Developments in Lubrication—J. P. Stewart, Head, Automotive Section, Research and Development Division, R. C. Moran, Supervising Chemist, and O. M. Reiff, Research Chemist, Socony-Vacuum Oil Co.

The purpose of the symposium was not only to emphasize some of the major current developments but also to indicate trends which may be of increasing significance in the future.

Considerable data were presented in the paper on "Exhaust Valve Materials" preceded by a review of some of the difficulties involved in test and research work. In laboratory testing of automobile valves mechanical properties and burning resistance can in general be satisfactorily determined on the dynamometer, but this method has many pitfalls, including the general tendency to use overaccelerated test conditions. The methods may fail to produce conditions occurring in service, and difficulties arise in setting up criteria of failure. On the other hand, road testing is time-consuming and expensive since it may take over 100,000 miles to burn the last of a set of mixed test and reference valves in a passenger automobile. In the case of aircraft engines, testing can usually be satisfactorily carried out in the laboratory.

An extensive table listed some 32 alloys, giving chemical composition, followed by data on scaling and rusting properties, information on the corrosion of alloys by lead compounds (*Calingaert* test), and one table gave hardness data. The authors point out that the martensitic (pearlitic) steels have been and still a e the most widely

used for passenger car purposes. Such steels are still reasonably adequate for the great majority of passenger cars but slight increase of duty is likely to change this situation and make the use of austenitic steels more or less imperative.

In connection with aircraft engines, austenitic steel is in practically universal use, alloy No. 15 with internal cooling and faced seats on the valves being the most widely employed. This alloy has 13 to 15 per cent chromium, 13 to 15 per cent nickel, 1.75 to 3.0 tungsten, 0.50 maximum molybdenum, 0.40 to 0.50 carbon, 0.30 to 0.80 silicon, balance, iron. Aircraft engine valves are frequently internally cooled and facing the seat of the valve with cobalt-chromium-tungsten alloy is widely practiced.

Chromium appears to be the outstandingly useful element in exhaust valve alloys. Chromium-iron-carbon alloys, however, are lacking in hot strength and hot hardness and the addition of an austenizing element is necessary where these properties are of pronounced importance. Nickel is the most widely used austenizing element at present. In the majority of valve steels relatively high carbon has been found to be advantageous in both martensitic and austenitic steels with respect to hot strength, hot hardness, and wear resistance. For scaling resistance (burning), chromium appears to be the most important element.

The major factor discussed in the paper on "Selection and Application of Automotive Steels" was significance of hardenability which is coming into usage in connection with the proper selection and application of steels instead of using other bases now in effect, primarily chemical and certain other physical properties. While additional information about cooling ratio is required for the most effective use of hardenability tests, it is hoped this information can become available in the not too far distant future as a help in deciding what tests to standardize.

The authors discussed present-day reasoning used in selecting steels and covered typical parts such as piston pins, camshafts and gears, indicating how service and manufacturing requirements including strength, wear resistance, machinability, and costs affect the ultimate selection.

Symposium on New Materials in Transportation

The papers comprising this symposium, together with discussion, will be published in a special volume later in the year—further announcements will be made concerning this. Attention is called to the fact that those wishing to submit written discussion of any papers should send this to A.S.T.M. Headquarters before April 20.

Doctor Cadwell made an effective presentation of his paper "Rubber of Tomorrow," demonstrating certain tests in the course of it to illustrate some of the properties of newer products in the field of rubber. For instance, he showed a sample of natural rubber and one of Neoprene which had been in gasoline for a week at room temperature. The one made of rubber had increased approximately 114 per cent in weight, the Neoprene only about 12 per cent. Special advantage can be taken of its resistance to oil absorbing tendencies.

He pointed to a fallacy that in vibrating or oscillation it seemed evident that a piece of rubber would last longest if it returned to the condition of zero strain during each cycle, but that in some cases this is the worst possible choice of conditions. In one example starting with the rubber under a minimum extension of about 200 per cent resulted in a dynamic fatigue life at least one hundredfold greater than when the minimum strain was zero.

Doctor Cadwell stressed that the newer synthetic-like materials are not synthetic rubber, but they can be made to resemble rubber in physical and chemical behavior. What the scientists are doing is not building a laboratory

Detroit Members in Charge of Local Arrangements.—Seated, from left to right: Martin Castricum, T. A. Boyd, J. L. McCloud, C. H. Fellows, C. E. Heussner, W. H. Graves; standing, from left to right: Sydney Bevin, F. P. Zimmerli, J. W. Kennedy, J. H. Walker, W. C. Du Comb, H. C. Mougey, W. P. Putnam.

replica of nature's rubber tree, but shaping specific molecules to meet specific needs. He described cellular rubber which has the individual pores or cells walled off from each other. This material is effective in reducing impacts and is also coming into usage for both noise and heat insulation. After mentioning other products, he discussed the pneumatic tire which is still the major use of rubber in transportation and commented on the increasing use of rayon tire cord, which, he said, shows that the chemist and engineer need not try to imitate nature but can, through a direct attack on the molecular structure, build up a material to suit a particular need.

Miles D. Catton in reviewing advances in the uses of concrete said that most of the advances were brought about by a more intimate knowledge of the physical characteristics of concrete. Advances in design have brought about more economical and efficient concrete roadways and airport runways and the efficient "rigid frame bridge." Architectural concrete has been developed for beauty as well as economy, and color in concrete has come along to increase the variety of treatment at the command of the architect. The "shell type" roof offers additional flexibility in design. An entirely new material, soil-cement, has been developed in less than 5 years which has already made a substantial impression in the light traffic road field.

In the paper on "Recent Developments in the Use of Asphalt for Transportation Purposes" it was indicated that one important development in asphalt pavements is the increasing attention to subgrade—the actual design of the subgrade as a part of the composite pavement structure having definite minimum support values. The almost universal use of balloon tires has so reduced load concentrations that even though traffic volumes have increased greatly, the damaging effects of impact formerly experienced have now disappeared. Mr. Gray also pointed out that the development of modern power equipment with attendant low cost of operation has greatly extended the radius of economical haul of selected aggregates and mixtures, as well as manipulation on the roadbed.

Surface types formerly in the higher cost class are now competing in the low cost field, while the quality of all types is markedly improved. Also, there is a definite trend toward use of plant mix types, because of lower plant costs and *immediate* use of road after placement.

There is a definite trend, the author said, toward use of coarse graded asphaltic concrete both in rural and city work and a growing use of asphaltic concrete for both base and surface courses. Asphalt surfaces for airports are the predominant type, with the trend toward plant mix types using both travelling and central plants. Recent experimental work in construction of asphalt ballast under railroad tracks opens a new field of use.

Messrs. Barnard and Fox in their paper on the properties of volatile liquid fuels summarized trends particularly during the last decade of the properties of four volatile fuels manufactured from petroleum; namely, motor fuels, aviation fuels, domestic furnace oils, and high-speed Diesel fuels. Of these, motor gasoline is a striking example of the results of concentrated effort to keep pace with rapidly increasing quantity demands and at the same time meet the requirements for the improvements in performance imposed by the development of the motor vehicle from a horseless carriage to a highly coordinated mechanism. Tracing certain manufacturing methods he showed the steady development of test methods for determining various quality properties of gasoline, particularly during the past ten years.

Doctor Barnard, who presented the paper, mentioned that there is a growing need for standard specifications for high-speed Diesel fuels similar to those now in use for motor gasoline, aviation gasoline, and domestic furnace oils, as issued by the Society. In concluding, he attempted to summarize the trends in terms of requirements for standardized tests, giving conservative predictions on whether certain tests would be required in the next ten years, and whether existing procedures would be adequate. In connection with motor fuels, it was indicated that the present octane number would probably not be adequate and the same would also apply in connection with aircraft fuels. The distillation test for domestic-furnace oils was questioned as being of doubtful adequacy and in connection with the high-speed fuels both the ignition quality (cetane number) and distillation is of doubtful adequacy over the next ten-year period.

Mr. Stewart in his paper "Developments in Lubrication" pointed to ordinary grease racks which are seen at most filling stations as evidence of progress in developing specific lubricants for specialized requirements such as wheel bearing, water pump, spring shackle and steering gear greases. A considerable portion of the paper was devoted to the subject of additives, and he indicated that in the development of gear lubricants and engine oil development the most feasible method of attaining the end desired seemed to be the addition of a compound or compounds that will impart the desired properties to an oil which already has received the optimum of subtractive refining. Additives are classified broadly as refining adjuncts and refining supplements, the former being more suitable than refining for conserving certain desired characteristics. Pour point depressants and viscosity index improvers were examples. Concerning refining supplements, the corrosion problem which developed about 1935, particularly of hard alloy bearings, was solved with supplements and primarily organic derivatives of phosphorus. Sulfur derivatives have also proved effective in preventing corrosion failure. In controlling acidity, sludge and lacquer formation and also effective in connection with pour point and viscosity index, which makes it both a refining adjunct as well as a supplement, is a newer type of complicated organic base.

A publication containing these technical papers and discussion of them will be issued by the A.S.T.M. in the next few months.

A.S.T.M.

1940 Photographic Exhibit

Chalfonte-Haddon Hall

ATLANTIC CITY, JUNE 24–28

See page 7 for details

Many Actions Recommended at Committee Week in Detroit

New Standards Proposed; Research Work Develops

Some 110 meetings of A.S.T.M. committees were held in Detroit during what has come to be known as A.S.T.M. Committee Week, March 4 to 8, inclusive. The total registration for these meetings was 460. While not as high as for other "Committee Weeks" in recent years, notably those held in Columbus and Rochester, it is considered quite good when considered in the light of the number of committees participating. The fact that fewer meetings were held in Detroit is no indication that the Society's work on standardization and research is diminishing, for many of the standing committees for various reasons did not take part in Committee Week this year but held meetings in other locations; for instance, the Committees on Electrical Insulating Materials, Plastics, Petroleum Products, Cement, and Copper and Copper Alloys met recently in Washington, while the Committees on Soap, Textile Materials, Gypsum, Fire Tests of Materials and Construction, and Mortars for Unit Masonry have held or are holding sessions in other cities.

All of the committee meetings in Detroit were well attended and the committee announcements, many of which are given in the remainder of this article, indicate numerous accomplishments in both standardization and research.

A list of the committees which met follows. In most cases a number of subcommittee meetings and sections were also held in connection with the main committee meetings:

A-1 on Steel
A-3 on Cast Iron
A-5 on Corrosion of Iron and Steel
A-7 on Malleable Iron Castings
A-10 on Iron-Chromium-Nickel

B-2 on Non-Ferrous Metals and Alloys
B-3 on Corrosion of Non-Ferrous Metals
B-6 on Die-Cast Metals and Alloys
B-7 on Light Metals and Alloys

C-8 on Refractories
C-16 on Thermal Insulating Materials

D-3 on Gaseous Fuels (Subcommittees)
D-4 on Road and Paving Materials
D-5 on Coal and Coke
D-11 on Rubber Products
D-18 on Soils for Engineering Purposes

E-1 on Methods of Testing (Sections)
E-4 on Metallography

Research Committee on Fatigue of Metals

The outlines given below of various committee activities will give some idea of the progress made and of the programs which the committees have under way. *Most of the actions taken at the meetings will, of course, be submitted to letter ballot prior to formal recommendation to the Society,* this being particularly true in the case of actions in the standardization field. It will be noted that many new standards are being considered for recommendation to the Society for publication as tentative and that a number of existing tentative specifications and tests will be offered for formal adoption as A.S.T.M. standards.

Editor's Note.—This article includes notes of certain committee meetings not held in Detroit, including Committees D-2 on Petroleum Products, B-5 on Copper and Copper Alloys, D-9 on Electrical Insulating Materials, D-12 on Soaps, and D-13 on Textile Materials.

Steel

Subcommittees on forgings, pipe and tubing, and materials for high temperature service had a number of important actions approved. Five proposed new tentative specifications will be referred to letter ballot, four covering carbon and alloy steel forgings, the fifth, factory-made welding fittings for pressure piping. Many important revisions were approved in existing requirements. All of these will be detailed in the annual report of the committee.

The four proposed new forging specifications which culminate intensive work by sections of Subcommittee VI on Steel Forgings and Billets are as follows:

(a) Carbon Steel Forgings for General Industrial Use
(b) Carbon Steel Forgings for Locomotives and Cars
(c) Alloy Steel Forgings for General Industrial Use
(d) Alloy Steel Forgings for Locomotives and Cars

When approved by the Society, these will replace all existing forging specifications except the two covering blooms, billets and slabs (A 17) and car and tender axles (A 21); thus removing the present inconsistencies and modernizing all of the requirements. The sections in immediate charge included representatives from large consumers, respectively, of the so-called industrial and railroad forgings, and producers. The two railroad items correspond closely with standards of the Mechanical Division of the American Association of Railroads, major properties being practically identical.

In each of the carbon-steel standards are some eight classes arranged by treatment (from untreated to quenched and tempered) with tensile strength ranges from 47,000 to 90,000 psi. and yield points of 25,000 to 55,000 psi. Elongations run from 16 to 25 per cent and reduction of area from 20 to 40 per cent, all of these varying according to size classifications up to 20 inches inclusive.

In the alloy forgings (several leading technologists concerned with alloying elements assisted in this work) tensile strengths cover ranges from 80,000 to 125,000 psi. (yields from 55,000 to 105,000 psi.) with elongations from 16 to 28 per cent.

The requirements for factory-made wrought carbon and carbon-molybdenum steel welding fittings for pressure piping were prepared to be used with the A.S.A. standard for butt-welding fittings. The term "welding fittings" applies to butt welding or socket-end parts such as 45 and 90 deg. elbows, caps, tees, reducers, return bends, etc.

Heat-treatment requirements are provided and various physical tests. Basic materials (pipe, plate, forgings, etc.) are covered by reference to other A.S.T.M. material specifications with special chemistry in several cases, involving carbon-manganese-silicon-molybdenum ranges. The Section on Welding Fittings of Subcommittee XXII on Valves, Fittings, Piping and Flanges for High Temperature Service promulgated this proposed new standard.

Other important actions in the high-temperature field were approved—one dividing the 4 to 6 per cent chromium-molybdenum casting specifications into high and low-silicon grades; another involved micrographic requirements of carbon-molybdenum pipe for high pressures and temperatures. Provisions are being set up for agreement on hydrostatic testing of pipe in excess of 2800 psi.

As in previous years, Subcommittee IX on Steel Tubing and Pipe, held a protracted meeting with certain actions resulting of widespread significance. A special section, after much discussion recommended definite practices on hardness testing, a subject of much controversy. Brinell hardness tests which will be the governing test on tubes with wall thicknesses 0.200 in. or heavier, are to be made on the outside of the tube near the end or on the outside of a section cut from the tube. In the case of tubes with wall thicknesses less than $^3/_8$ in. down to and including 0.200 in., a 10-mm. ball with 1500-kg. load, or a 5-mm. ball with 750-kg. load, may be used, at the option of the manufacturer. Rockwell hardness tests will be the governing test on tubes with wall thicknesses less than 0.200 in., the impression to be made on the inside of samples cut from the tubes. It is hoped these recommendations eventually will come into widespread usage and tend to reduce misunderstandings which have frequently arisen in the past.

To complete a recommendation made in 1939 providing chemical and certain physical limits for a new higher tensile strength boiler rivet, Subcommittee XI on Boiler Steels, offered certain bend test requirements. This new rivet grade to be incorporated this year in the boiler rivet specifications A 31 has maximum carbon of 0.27 per cent; manganese 0.40 to 0.80 per cent and maximum silicon of 0.30, with a tensile range of 58,000 to 68,000 psi. (present grade A is 45,000 to 55,000 psi.) yield point of half the tensile strength and elongation of at least 23 per cent.

Cast Iron

As a result of work under way for some time Committee A-3 on Cast Iron through the work of its Subcommittee I on Pig Iron approved proposed new tentative specifications for pig iron, but before presentation to the Society they will be referred for comment and criticism to a number of producers and consumers of this material.

The group in charge of the specifications for automotive gray-iron castings (A 159 – 35 T) are developing changes to bring them in line with S.A.E. standards. It is expected that as revised the specifications will be recommended for adoption as formal A.S.T.M. standards.

Also to be referred for adoption are the tentative specifications for lightweight and thin-sectioned gray-iron castings (A 190 – 36 T), and cast-iron pipe and special castings (A 44 – 39 T). The existing revisions in the standard specifications for gray-iron castings for valves, flanges, and pipe fittings (A 126 – 30) are also to be referred to ballot for adoption, these latter involving the inclusion of a high-test cast iron with a tensile strength of 41,000 psi., transverse strength load at center, min. 4000 lb. and the deflection in center, min., 0.12 in.

Corrosion of Iron and Steel

Committee A-5 on Corrosion of Iron and Steel reviewed its work on specifications and also considered several of its very extensive atmospheric and sea water tests involving iron and steel products. All sheet and pipe specimens exposed in salt water at Portsmouth, N. H., and at Key West, Fla., have been removed and the tests will be discontinued. All sheet specimens have failed by fringing or by perforation. The 1940 annual report of Committee A-5 will include the final results of the above tests,

(*Continued on page 42*)

At 1940 Committee Week, Detroit, Mich.

Top, left to right—G. E. Hopkins, C. L. Warwick; R. L. Kenyon, R. L. Templin, F. M. Howell; W. F. Tuley, Arthur W. Carpenter.
Bottom, left to right—H. E. Smith, O. B. Schultz; T. A. Boyd, A. C. Fieldner; H. A. Depew, J. H. Ingmanson, H. M. Frecker, Jr.

The Use of Radiography in the Development of Castings for Mass Production[a]

By Don M. McCutcheon[1]

CAST PARTS for automotive uses now represent large production tonnages. For example, the Ford Motor Co. used over 7100 tons of copper-silicon steel castings during the month of February, 1939. In the past few years the number of cast parts replacing forgings or other manufacturing methods has shown a consistent increase. The part played by radiography in the development work on castings at the Ford Motor Co. may be of sufficient interest to warrant a description of the uses and technique employed.

Procedure in the Development of Cast Parts

Any part which is being considered for production as a casting must show definite manufacturing advantages when cast over an equivalent forging or assembled unit. In addition the casting must have suitable structure, strength, hardness, or other properties required by the use to which the part is subjected. The development procedure is outlined as follows.

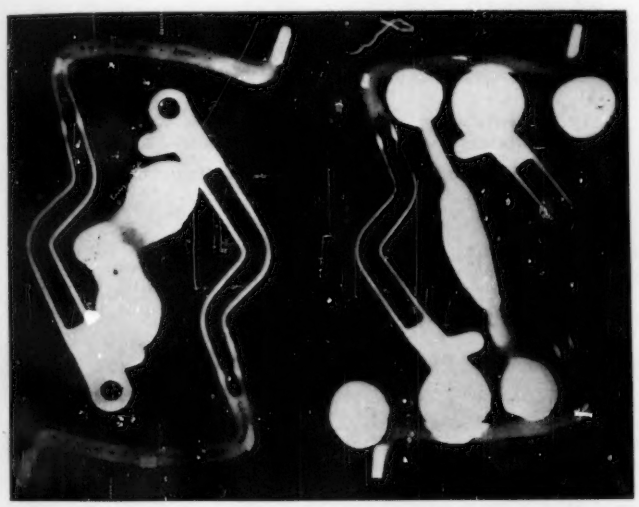

Fig. 1.—Two Test Castings Radiographed to Show the Influence of Location of Gates and Risers on Soundness.

Experimental Models Cast for Testing

A cast experimental part is given extensive physical and service tests before being accepted for production. The experimental foundry casts a number of test models, using a foundry technique believed to be best suited for that particular design. Casting costs are not restricted, so adequate gates and risers are provided to insure a sound casting. A very careful radiographic examination of these test parts is made, and no casting is accepted for testing purposes unless perfectly sound. Very often a change in experimental foundry technique or a modification of the metal analysis is necessary. Figure 1 shows a radiograph of two castings made by the experimental foundry during the development of cast brake pedals for busses.

Frequently a number of experimental models are cast and tested to determine the most suitable design. The cast crankshaft, for example, required considerable research on design and foundry technique to produce a perfectly sound casting and eliminate warpage during heat treatment. After successful experimental procedure had been secured for the crankshaft, a series of models was cast with varying designs, such as number and size of main bearings, location of reinforcing ribs, and other changes intended to increase the strength and rigidity. After testing and acceptance of an experimental cast part, the production foundry determines the correct procedure under mass-production conditions.

Production Casting

The most economical foundry procedure is sought in the production foundry consistent with the production of sound castings. A minimum amount of return metal is desired together with the most efficient sand mold and core design. The radiographic methods and technique have all been carefully worked out and standardized, so that the maximum speed and sensitivity control are consistently secured. Rapid methods are desirable at this development

Fig. 2.—Radiograph of Main Bearing of a Cast Crankshaft. A penetrometer gage, 0.5 per cent of the bearing thickness clearly shows on the original radiograph.

[a] Presented at the Forty-second Annual Meeting, Am. Soc. Testing Mats., Atlantic City, N. J., June 26–30, 1939.

[1] Research Engineer, Chemical and Metallurgical Dept., Ford Motor Co., Dearborn, Mich.

stage so as not to delay establishment of production longer than necessary.

Radiographic examination is not used in general for inspection testing of production castings after development work is completed, but only as an aid in the development of such tests. Where production is only moderate, however, as in the cast brake and clutch pedals for busses, 100 per cent X-ray inspection was made over a considerable period.

Radiographic Procedures

Castings designed for automotive use must be free from defects which are apt to cause any weakness in stressed parts. The radiographic method of examination easily detects gross defects, but it is in the detection of small defects such as very fine gas pockets or shrink cracks that carefully controlled radiographic procedures are required.

Preparation of the casting for radiographic examination, particularly on complicated shapes, requires careful attention to small details and observing the customary precautions to prevent excessive amounts of radiation from reaching the film adjacent to important areas. The cast crankshaft is typical of the rather difficult shapes which must be radiographed both rapidly and carefully. A sensitivity of 0.5 per cent is maintained on the $2^1/_4$-in. diameter bearings. Experience has shown that this limit is necessary, particularly to catch small gas holes which might show up on machining and grinding of the bearing surfaces. Figure 2 shows a radiograph of an experimental crankshaft, and illustrates the sensitivity regularly obtained. A strip of steel 0.010 in. thick was placed on the top of the bearing and can be clearly seen in the original radiograph.

The method of preparation used on the bearings of a crankshaft is shown by the cross-sectional view in Fig. 3. Standard radiographic clay, to which has been added very fine powdered lead, is used as a blocking medium. The absorption for X-rays in the blocking clay is regulated by the lead powder additions so that it is approximately twice the steel absorption. Only the top surface contour need be leveled, which results in considerable time saving. The use of drilled and split steel blocks is not entirely practical here due to interference of the counterweights and the constantly changing design of experimental models. Lead sheets $^1/_4$ in. thick are generously used to block off stray radiation. The time required for preparing a crankshaft for X-ray examination is 15 min. with an exposure time of $2^1/_2$ min. for the $2^1/_4$-in. bearing section. If necessary, two crankshafts can be examined simultaneously in a total time of 25 min. Two high-speed intensifying screens are used in a standard lead-lined cassette using ultra speed type of film.

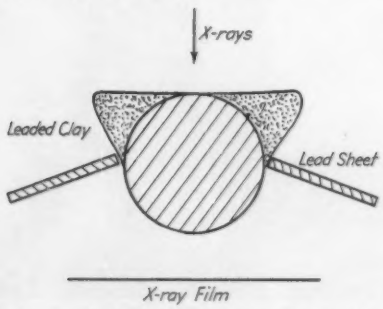

Fig. 3.—Method Used in Preparing a Crankshaft at the Bearings for X-ray Examination.

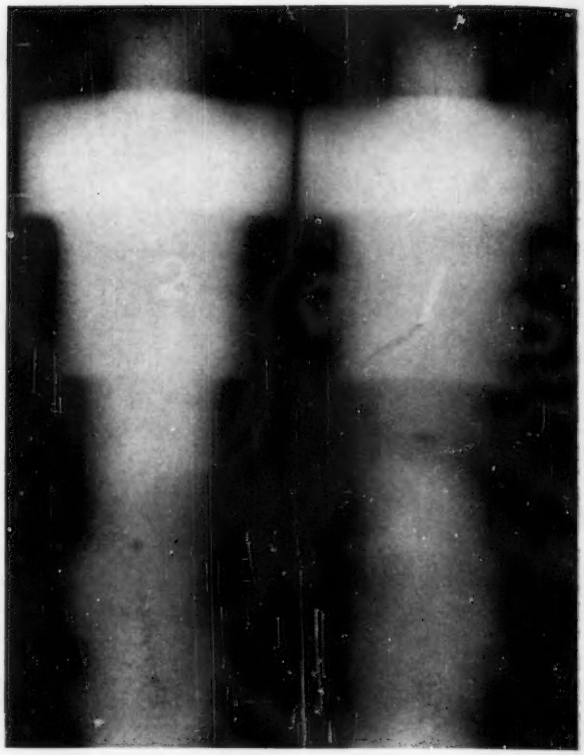

Fig. 4.—Experimental Cast Camshaft Radiographed by Immersion in Solution of Soluble Lead Salts.
Sensitivity is 1.5 per cent of section thickness.

Castings having widely varying thicknesses of metal section, as in a cast camshaft, are examined by immersion in a saturated soluble lead salt solution. Figure 4, shows a radiograph of an experimental camshaft and illustrates the effectiveness of this method. For heavy sections, up to 2 in. thick, a lead-lined cassette with one high-speed intensifying screen is used behind the film. The sensitivity in this case is somewhat reduced due to the unavoidable X-ray scattering in the solution. When using the solution method, it is customary to expose the films to a higher average density than is used for objects such as the crankshaft.

The lead solution used is acid in reaction and tends to form gas bubbles on the surface of the parts placed in the liquid. It is often difficult to distinguish in the radiograph between actual internal cavities in the cast steel part and gas bubbles formed on the surface of the part by the reaction with the lead solution. The addition of a small amount of acetone, or similar organic liquid, to the lead solution before immersion of the cast part reduces the tendency for the gas bubbles to adhere to the surface of the casting.

The most suitable substitute for the lead salt solution for cast steel parts is very fine copper shot.[2] After placing the casting on the film cassette and before adding the copper shot it is recommended that the film be given a short flash exposure to sharply outline the object on the film with a uniform black background. This procedure is particularly recommended where the radiographic films are

[2] C. D. Moriarity, "The Use of Metallic Shot in X-raying Steel," *General Electric Review*, Vol. 42, No. 3, March 1939, p. 109.

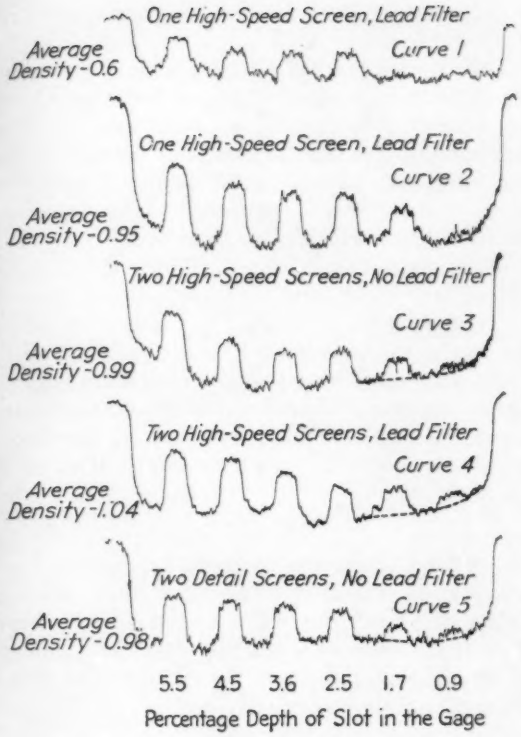

Fig. 5.—Curves Obtained on Recording Type Microphotometer.

to be examined by persons not familiar with this method of examination.

Radiographic Sensitivity Tests

Specific information was desired on the limiting sensitivity of our radiographic equipment. The smallest difference in metal section which could be determined by visual examination of the radiograph was accordingly determined.

Experiments were made with a steel section 2.195 in. thick to determine the effect on sensitivity and contrast of using a lead filter in conjunction with various intensifying screens. A standard A.S.M.E., boiler code penetrameter was placed on top of the 2-in. steel section. This gage was 0.195 in. thick and had various depths of slots cut into one face. The X-ray tube was operated at 220 kv.p., 10 ma., and at a distance of 40 in. from the film.

The density variations of test films were calculated from the curves in Fig. 5 obtained on a recording type microphotometer of our own design. Check values were obtained on a Bausch & Lomb densitometer. The curves show that the density of some of the test films drops suddenly at sensitivities around 2 per cent. This condition is most pronounced for films exposed to a density less than 1.00, as can be seen by comparing curves 1 and 2 of Fig. 5. A density of 0.7 has often been recommended for radiographic films, but we find that maximum sensitivity is only secured at densities in excess of 1.0.

Microphotometer curve calculations can best be made by substracting the background density from the density of the film at each step of the gage. This is usually designated as $(S - S_o)$, and can be most conveniently described as the "contrast factor" of the respective films. Figure 6 shows the contrast factor plotted against the percentage of section thickness at each gage step. The superiority of curves 2 and 4, Fig. 6, indicates the desirability of using a filter with either one or two high-speed intensifying screens.

Previous work has shown that a density difference, or contrast factor, of 0.02 is the practical limit that can be seen with the eye under ideal conditions.[3,4] The test films which we have run agree with this value. Where the microphotometer curve, shown in Fig. 6, falls much below a contrast factor of 0.02, density differences in the original radiograph cannot be seen by the eye. This effect becomes all the more serious when it is realized that most defects are not sharp edged and produce a gradual shading of density in the film. The recording microphotometer can detect changes in density less than 0.005, which is about the order of magnitude of the variations in density due to graininess and other causes in the film.

Examination of the curves of Fig. 6 shows that a sensitivity of 1.0 per cent is readily obtained with filtered or unfiltered X-ray beams for films whose average density exceeds 1.0. The possibility of extending this limit of sensitivity is indicated by curve 4, where a lead sheet 0.005 in. thick is used as a filter on top and beneath the two intensifying screens in the cassette. A contrast factor of approximately 0.02 is secured for a sensitivity of 0.5 per cent. Experience on the radiography of experimental crankshafts over the past 2 yr. has shown that a sensitivity of 0.5 per cent can be maintained by the proper care in preparing the part for radiographic examination.

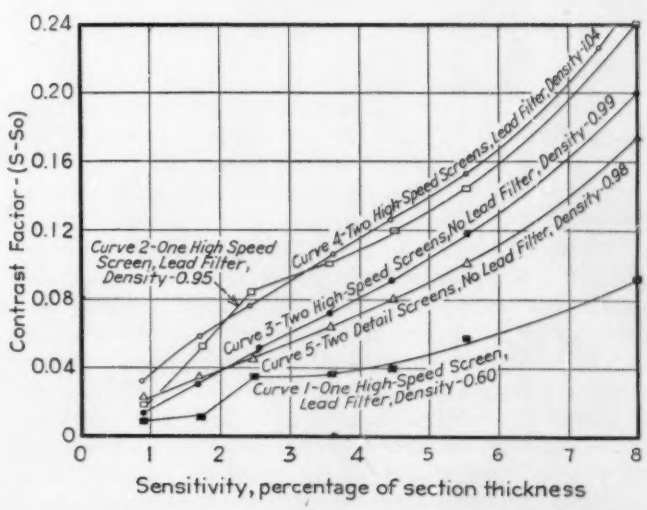
0.24
0.20
0.16
0.12
0.08
0.04
0
Contrast Factor - (S-So)
Curve 2-One High Speed Screen, Lead Filter, Density-0.95
Curve 4-Two High-Speed Screens, Lead Filter, Density-1.04
Curve 3-Two High-Speed Screens, No Lead Filter, Density-0.99
Curve 5-Two Detail Screens, No Lead Filter, Density-0.98
Curve 1-One High-Speed Screen, Lead Filter, Density-0.60
0 1 2 3 4 5 6 7 8
Sensitivity, percentage of section thickness

Fig. 6.—Photographic Contrast Obtainable with Decreasing Percentage of Section Thickness by Five Methods.
Density measured at 2.195-in. thickness.

Detection of Small Defects

When the radiographic process was first introduced at the Ford Motor Co. in 1931, the detection of gross defects aided the development of better foundry technique. In 1933 a control on the radiographic process was established by requiring a 2 per cent penetrameter gage placed on each

[3] R. Glocker, "Materialprüfung mit Roentgenstrahlen," p. 71, Julius Springer, Berlin (1936).

[4] John T. Norton, "The Principles of the Radiographic Process," Symposium on Radiographic and X-ray Diffraction Methods, p. 16, published by the American Society for Testing Materials (1937). (Symposium available as a separate publication.)

part examined to show clearly on the developed film. This sensitivity was soon found to be inadequate. Occasional complaints were received that small defects were showing up on machined surfaces of parts which had been passed by the radiographic inspector. The establishing of a radiographic sensitivity of 0.5 per cent on 2-in. sections which are subsequently machined and ground has been found sufficient to catch all objectionable defects. Every cast part is radiographed with a small penetrameter gage, of either the stepped type with holes punched in the center of each step, or the slotted type, as described in the A.S.M.E. Boiler Code.[5] Where it is convenient to build up an artificial section of equal thickness adjacent to the part under examination, the slotted type of gage is used; otherwise the stepped type of gage is placed upon the top of the important sections during exposure.

Where radiographic examination shows the occurrence of defects in experimental cast models, the part is sectioned through the center of the defect. Progress in the elimination of defects by changing experimental foundry technique is followed both by radiography and the sectioning of each model through the center of the defective areas shown in the radiograph. For sound castings the inspector reports that the radiograph shows no defects within the sensitivity range indicated by the image of the penetrameter on the film.

The detection of cracks by radiography is generally considered to be rather difficult. Magnaflux magnetic testing is used at the Ford Motor Co. as a supplement to the radiographic method for the detection of cracks in forged, welded, and cast ferrous metal parts. Casting cracks occasionally occur in new experimental parts as a result of differential shrinkage between the metal and the sand cores on cooling after pouring. Larger fillets and close control on sand conditions aid in reducing the occurrence of this type of defect. Fortunately the location and angle of casting cracks can usually be anticipated in small cast parts allowing most favorable positioning of the castings during radiography. Examination of suspected parts by both radiography and magnetic testing methods has shown that radiography is sufficiently reliable to detect most such defects.

Summary

Radiographic inspection methods have played an important part in the development of improved foundry methods at the Ford Motor Co. by the use of cast models before the establishment of mass production. A number of curves are shown illustrating the radiographic technique employed in securing a sensitivity of 0.5 per cent on cast crankshaft bearings 2 in. thick.

[5] Rules for the Fusion Process of Welding, Paragraph U-68, A.S.M.E. Boiler Construction Code, Section VIII, p. 499 (1935).

DISCUSSION

Mr. H. H. Lester[1] (*presented in written form*).—Mr. McCutcheon brings out the use of radiography for the purpose of developing manufacturing technique. This use of the test method is perhaps the one that will return the greatest dividends in the end.

The author speaks of a radiographic sensitivity of 0.5 per cent. It is pointed out that this value should be stated only with reference to the particular gage used. The gage, or penetrameter, that has been sanctioned by the A.S.M.E. Construction Code for welded pressure vessels, contained drilled holes $^3/_{16}$ in. in diameter. This could in some cases indicate sensitivities as high as 0.5 per cent, but with holes smaller in diameter the sensitivities possible to obtain were more on the order of 2 per cent. As a matter of fact, a penetrameter should not be regarded as a sensitivity gage since its sensitivity indications depend upon the geometry of the device. It is properly used to check the correctness of the radiographic procedure.

Mr. Alexander Gobus.[2]—I would like to ask concerning the penetrameter used. If it contained no holes, would you call that a real test for sensitivity?

Mr. Don M. McCutcheon[3] (*author's closure by letter*).—The comments by Mr. Lester are appreciated. The use of radiography in the development of sound castings is amply justified by the service record of over 5,000,000 crankshafts cast in the past few years. Mr. Lester is correct in stating that the sensitivity as reported in this paper refers to cavity sensitivity and not crack sensitivity. Fortunately, in our work the occurrence of casting cracks in experimental models is rare. The use of the Magnaflux magnetic test as a supplement to radiographic inspection is a sufficient safeguard.

Replying to the question raised both by Mr. Lester and Mr. Gobus, relative to the type of gage used on the crankshaft bearing shown in the radiograph, Fig. 4, a thin strip of steel 0.010 in. thick without holes was used in place of the standard penetrameter for convenience of reproduction. An attempt was made to control the photographic reproduction of this radiograph to maintain the relative density difference that exists in the original film. It is physically impossible to reproduce the standard gage containing holes at a section sensitivity of 0.5 per cent by any known photographic process.

[1] Senior Physicist, Watertown Arsenal, Watertown, Mass.
[2] Metallographist, Lucius Pitkin, Inc., New York, N. Y.
[3] Research Engineer, Chemical and Metallurgical Dept., Ford Motor Co., Dearborn, Mich.

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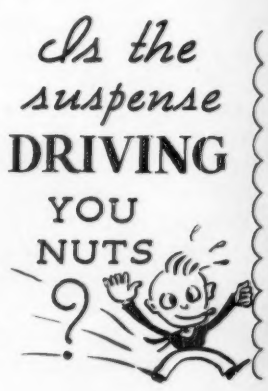

Symposium on Significance of the Tension Test of Metals in Relation to Design

Foreword by John M. Lessells[1]

EDITOR'S NOTE.—The committee in charge of the Symposium on Significance of the Tension Test in Relation to Design, one of a series of technical discussions planned in connection with the subject "Significance of Mechanical Properties of Metals" consists, in addition to Professor Lessells, *Chairman*, Massachusetts Institute of Technology, of Col. G. F. Jenks, U. S. Army; Prof. H. F. Moore, University of Illinois; N. L. Mochel, Westinghouse Electric and Manufacturing Co.; and R. E. Peterson, Westinghouse Electric and Manufacturing Co. The American Institute of Physics and American Society of Mechanical Engineers are cooperating closely. Mr. Peterson is acting as representative of the A.S.M.E. Applied Mechanics Division. It is expected that synopses of the three papers forming the basis of the Symposium will be published in the Provisional Program in the May ASTM BULLETIN.

A Symposium on the Significance of the Tension Test in Relation to Design is planned for the Forty-third Annual Meeting of the American Society for Testing Materials, at Atlantic City, N. J., in June. This symposium will be devoted to the presentation and discussion of a group of papers dealing with the tension test of metals, with the twofold object of attempting to clarify the relationships between fundamental characteristics measured in such a test and, in addition, the relating of such characteristics to the design problem.

The value of such a symposium will depend very largely upon the amount and character of the discussion which these papers bring forth. It is therefore earnestly hoped that all those engineers who are interested in inquiring into the physical significance of the quantities determined in the tension test and their relationship to design will take part in the discussion so that the basis of our present knowledge on this subject will be considerably broadened.

In order to prepare the way for such discussion the writer, as Chairman of the Committee in charge of the Symposium, submits the accompanying observations on the tension test as a Foreword to the Symposium.

The present Symposium will consider only the tension test as made at normal temperatures and will not attempt to explore the effects of either high or low temperatures.

Forms of Tests Used

The various forms of tests used by the engineer to assess his materials can be divided into two groups: (*a*) fundamental type and (*b*) arbitrary type. The first type provides data which can be directly used for design purposes and the tension test is one of the most important, if not the most important, one in that group. The fatigue test is likewise an important test in this same group. The second type or arbitrary tests are well represented by the impact test and flexure test. While these are important tests in the control of materials they do not in their present stage provide data which can be directly used in design, hence their classification here as arbitrary. These facts have probably been recognized for the long period of years in which tension test data have been used. Even today many engineers continue to apply tension test data for the design of members subjected to a wide variety of stress conditions. Modern thought has probably contributed most to setting limits on the conditions where such data can be applied and has indicated those cases where more information is required for the best and most economical designs. It is of interest to observe here that from the results of modern research it is known that the fatigue strength is as nearly related to the tensile strength as with any other physical property. While this relationship varies over wide limits, designs subjected to cyclic or variable stress may be somewhat rational if based on the tensile strength. It is well known, however, that such an approach cannot be very accurate and it does not take into consideration the effect of stress concentration which can only be done by looking at the design problem from a wider viewpoint.

Code for Working Stresses

In attempting to prepare a code for working stresses it is at once apparent that there are very few tests upon which a good foundation can be built. In the theory of elasticity, stress and strain are treated from a three-dimensional aspect but most of our knowledge concerning the behavior of materials rests on the results of simple uni-directional tests. In this respect the tension and fatigue tests are the most important. This picture may, of course, be changed when more data become available in the behavior of materials under combined stresses.

In the following the choice of working stress based on the yield strength or endurance limit is considered. It is recognized that in failure by buckling the critical stress rather than the yield strength is the governing factor. Such conditions have not to date been included in the code being discussed here.

Accepting the tension and fatigue tests as the basis of our reasoning, stresses are classified as either steady or variable. The generalized[2] condition of variable stress as in Fig. 1 (*a*) may be considered as consisting of a steady stress S_m and a variable stress S_r.

The case of a pulsating stress is represented in Fig. 1 (*b*) and a completely reversed stress by Fig. 1 (*c*). In this latter case $S_r = S_e$ = endurance limit for reversed stresses.

Materials are further classified as being either ductile or

[1] Chairman of Committee on Symposium on Significance of the Tension Test of Metals in Relation to Design; Associate Professor of Mechanical Engineering, Engineering Dept., Massachusetts Institute of Technology, Cambridge, Mass.

[2] The following papers should be consulted: C. R. Soderberg, "Working Stresses," *Transactions*, Am. Soc. Mechanical Engrs. (1933). C. R. Soderberg, "Working Stresses," Design Data, Am. Soc. Mechanical Engrs. Schaubilder, "Dauerfestigkeit" Zeitschrift Vereines deutscher Ingenieure (1933/1934).

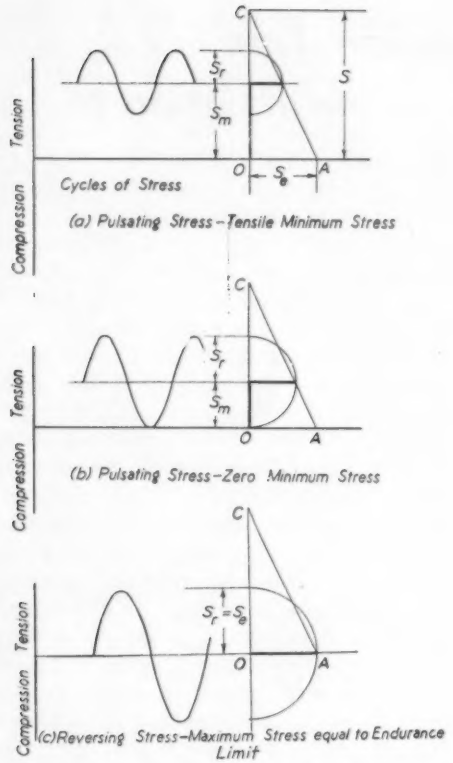

Fig. 1.—Graphic Representation of Steady and Variable Stresses; Pulsating Stress; and Reversed Stress.

brittle. Obviously the limiting conditions for the case of steady stress must either be the tensile or the compressive strength and for that of variable stress the endurance limit.[3]

Or if S = tensile or compressive strength
and S_e = endurance limit for reversed stresses
the variable stress $S_r \not> S_e$
and steady stress $S_m \not> S$

For the case of a ductile material the limiting condition will be as represented by *OAC* in Fig. 2. The line of failure for certain materials falls above *AC* but for simplification this is taken as *AC*. Such an assumption is, however, on the safe side. Any stress condition which falls outside of *OAC* according to this reasoning, which excludes hardening due to plastic yielding, will result in failure. The case represented by OAC_1 for compressive stresses is not so well clarified since in this case the criterion of failure is less definite. Certain experimental values do, however, conform to AC_1 for negative mean stresses.

In the case of steady stress for ductile materials it is customary to take not the value of the tensile strength $S = OC$ as the limiting stress but rather the value of the yield stress $S_{y.p.} = OB$. This means that the zone of failure is now represented by *OAB* for positive mean stresses. As before, any stress condition within this area will not result in failure and this area will represent all combinations of stress varying from a steady stress *OB* to a variable stress *OA*.

[3] This assumes that the range of stress begins to decrease when the mean stress of the cycle becomes compressive. This is true in general but some exceptions have been noted.

This general approach to the problem of working stresses has much to commend it. Some notable exceptions in the case of helical springs have been noted by Zimmerli[4] which deserve mention. Heat-treated chrome-vanadium steel springs to give a tensile strength of 205,000 psi. indicated a torsional endurance range of 75,000 psi. for stresses varying from zero to a maximum, whereas stainless steel spring (17.4 per cent chromium, 8.9 per cent nickel) treated to give a tensile strength of 216,000 psi. only indicated a torsional endurance range of 29,000 psi. when tested under similar stress conditions. Probably, however, these discrepancies, not explained by Zimmerli, are due to residual stress or surface effects which might be traced from a study of the elastic part of the tension test. In this discussion the effects of plastic flow due to tensile overstrain have been neglected. Haigh,[5] however, has shown that such overstrain can increase the maximum value of the variable stress to such a degree that the extreme value of $S_r + S_m$ approaches the tensile strength of the material. Some application of these ideas by Zimmerli to the improvement in helical springs by shot blasting will be mentioned later.

The above refers to ductile materials. For the case of brittle materials the tensile and compressive strength must be regarded as the limits of failure but this case is more complicated by the fact that the properties of such materials in tension and compression are usually different.

The above method allows also consideration being made of stress concentration effects. It is well known that rapid changes in section of machine parts lead to stress

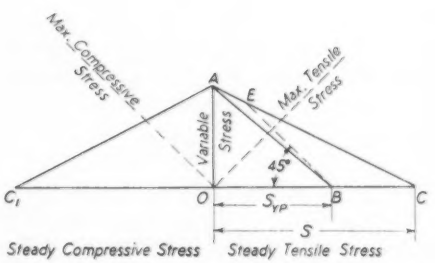

Fig. 2.—Limiting Stress Conditions for Steady and Variable Stresses.

concentration. It is also generally accepted that for ductile materials such stress concentrations are less dangerous for cases of steady stress than for cases of variable stress. With this understanding, factors of stress concentration established by photoelastic research are well known and can be applied to the variable stress S_r (Fig. 1). The results obtained by the application of theoretical factors are, in cases of departure, on the safe side.

Figure 3, which has been reproduced from Fig. 2, indicates the conditions of steady and variable stress, the line *AB* representing the assumed line of failure.

Although *AB* represents the assumed line of failure, every engineer will choose a factor of safety in order to cover the discrepancies which might occur in the load de-

[4] F. P. Zimmerli, "Permissible Stress Range for Small Helical Springs," *Bulletin 26*, Engineering Research Station, University of Michigan, 1934.

[5] B. P. Haigh, "Fatigue in Structural Steel Plates with Riveted or Welded Joints," *Transactions*, Inst. Naval Architects (1939).

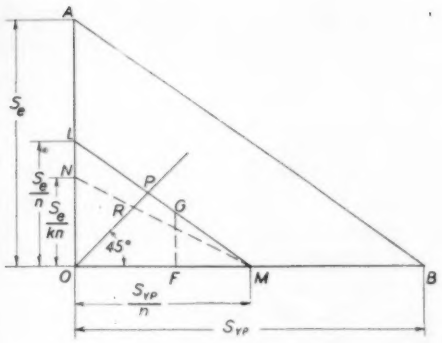

Fig. 3.—Graphical Method of Determining Magnitude of Steady and Variable Stresses.

terminations, in the stress calculations, and in the material. If this factor be taken as n then the design limitations will be set by line LM where $OL = S_e/n$ and $OM = S_{y.p.}/n$. The general case[6] will then be determined by the coordinates of a point such as G where the steady stress S_m is represented by OF and the variable stress S_r by FG. Given the values of endurance limit and yield strength and a knowledge of the particular mode of stress variation the values of the variable stress S_r and the steady stress S_m can easily be obtained by graphical means.

If a machine part be made of medium-carbon steel such that the yield strength $(S_{y.p.}) = 42{,}000$ psi. and endurance limit $(S_e) = 30{,}000$ psi. and this part be subjected to a stress varying from o to $S_{max.}$, then if the factor of safety n be taken as 2, triangles OAB and OLM can be drawn such that $OL = 30{,}000/2 = 15{,}000$ psi. and to the same scale $OM = 42{,}000/2 = 21{,}000$ psi. For the above stress condition $S_m = S_r$ and this will be represented by a line OP drawn from o at 45 deg. to OB. The coordinates of the point P of intersection of this line with LM gives the values of S_m and S_r. For this particular case $S_m = 8750$ psi. and $S_r = 8750$ psi. or $S_{max.} = S_m + S_r = 17{,}500$ psi.

Consideration of Stress Concentration

If now this same machine part has a change in section such that the stress concentration factor[7] k is 1.4, the same approach can be used to arrive at a satisfactory design. For such conditions it is assumed that any correction for stress concentration need only be applied to the variable part of the stress. This assumption seems justified on the grounds that stress concentration when applied to steady stress on ductile materials will only lead to local yielding and hence a more favorable stress distribution.

Applying these data to the case under consideration, point N is determined from the condition that $ON = S_e/kn = 30{,}000/1.4 \times 2$. The point N so obtained is joined with M and, as before, the coordinates of point R of intersection with the 45-deg. line from o determines the values of S_m as 7200 psi. and S_r as 7200 psi. This means $S_{max.}$ for this case becomes 14,400 psi. as compared with 17,500 psi. with no stress concentration. In other words this method of approach provides the designer with a tool whereby the effects of stress concentration can be fully regarded in his design.

Steady and variable stress conditions can also be represented by a diagram, the ordinates of which are maximum-minimum stress and the abscissas the mean stress of the cycle. This is the method shown in Fig. 4 as adopted by the Vereines deutscher Ingenieure[8] in their design sheets and has been found of considerable value in certain laboratories in this country. This method has the distinct advantage of showing at a glance the effects of stress concentration.

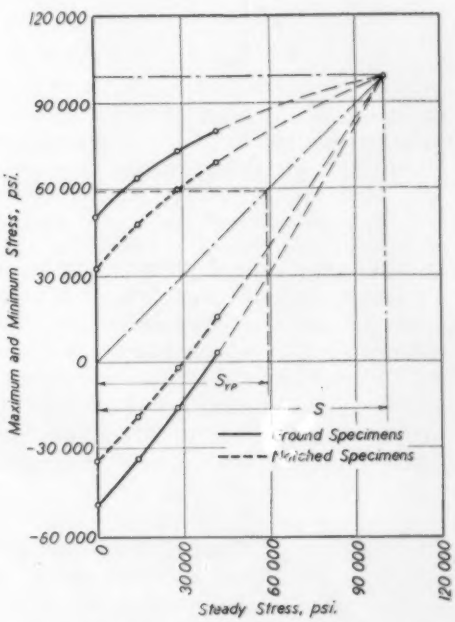

Fig. 4.—Graphical Method (Adopted by V.D.I.) for Determining Magnitude of Steady and Variable Stresses.

Importance of Yield Stress

The above brief summary of the present engineering viewpoint leaves many points on which more information is desired. In choosing the yield stress as the basis of failure for steady stress conditions are we on solid ground? This choice seems logical for those materials which have a definite yield point, but is the stress value corresponding to an extension of 0.2 per cent justified for materials like copper or aluminum alloys which have no yield point in view of the known benefits of plastic flow? The contributions of Nadai[9] and his coworkers have done much to

[6] *Loc. cit.*, C. R. Soderberg. See also S. Timoshenko, "Strength of Materials," Part II, D. Van Nostrand Co., New York, N. Y., from which the above example is taken.

[7] For tables of actual values see M. M. Frocht, "Factors of Stress Concentration," Design Data, Am. Soc. Mechanical Engrs. (1939); and N. C. Riggs and M. M. Frocht, "Strength of Materials," Ronald Press (1938).

[8] *Special Design Sheet No. 42*, V. D. I., October 21, 1933. Schenck, *Stahl und Eisen*, Vol. 52, p. 660. Also discussion by R. E. Peterson of Appendix to Report of the Research Committee on Fatigue of Metals: Nomenclature for Various Ranges in Stress in Fatigue, *Proceedings*, Am. Soc. Testing Mats., Vol. 38, Part I, p. 162 (1937).

[9] A. Nadai, "Plasticity," McGraw-Hill Book Co., Inc., New York, N. Y.; also E. A. Davis, "Effect of Speed of Stretching and Rate of Loading on the Yielding of Mild Steel," *Transactions*, Vol. 60, pp. A-137–140, Am. Soc. Mechanical Engrs. (1938).

clarify our understanding of yielding phenomena but much yet remains to be done. Since it is to be expected that work on combined stress will develop in future years, what should be the criterion of failure for such conditions? The beneficial effects of overstrain are mentioned above. From the work which has been done on the shot blasting of helical springs resulting in a very substantial increase[10] in the safe fatigue range under stress conditions which represent a steady torsional stress plus variable torsional stress, it may be that the choice of yield stress as now defined as the limit of failure for steady conditions is unduly conservative.

The importance which yield stress plays in the applications of materials may be shown in another way. Referring to Fig. 1 (*b*) it is apparent that if the stress remains pulsating and does not become reversing

$$S_m \geqslant S_r$$

This means that a line *BE* drawn as in Fig. 2 at 45 deg. to *OC* will satisfy conditions that $S_m + S_r = S_{y.p.}$. Any point to the left of *E*, the point of intersection of fatigue line *CA*, will represent conditions where fatigue failure is likely to occur prior to yielding because

$$S_m + S_r < S_{y.p.}$$

Any point to the right of *E* will represent conditions where yielding is likely to occur prior to fatigue because $S_m + S_r > S_{y.p.}$. In the case of an annealed 0.3 per cent carbon steel the value of S, $S_{y.p.}$, S_e, represented, respectively, by *OC*, *OB*, and *OA* will be of the order of 70,000, 37,000, and ± 30,000 psi., respectively. In the case of alloy steels the value of the yield stress $S_{y.p.}$ will be increased to a much greater percentage of the tensile strength than is the increase in endurance limit. For instance, for an oil hardened and tempered 3 1/2 per cent nickel-chromium steel[11] the values of $S_{y.p.}$, S and S_e would be changed to 128,000, 138,000, and ± 68,000 psi., respectively. Accordingly, using the same convention, point *E* in Fig. 2 will move nearer to *C* increasing the possibilities of fatigue failures occurring before the yielding takes place.[12] It is recognized that point *E* is only a rough approximation since experiments show that fatigue failures may not take place until the stress has exceeded that at *E*. If, however, point *E* is taken this means that in the case of a carbon steel there is more likelihood of local yielding occurring, thereby allowing a redistribution of stress, than in the case of alloy steels. To apply this to an actual design problem, is it better to use a carbon steel in an aircraft engine connecting rod stud where the yield point is nearer to the fatigue strength or an alloy steel where the yield point is considerably in excess of the fatigue strength?

High Yield Ratio Steels

All of these phases of the strength problem seem to be involved in a discussion of strength properties as shown by the tension test. They also raise the question of the efficacy of high yield ratio steels under variable stress conditions.

Importance of Ductility

Regarding the question of ductility values obtained from the tension test, engineers might classify ductile materials as those which show an elongation in the tension test of 5 per cent and over, and brittle materials as those which indicate less than 5 per cent. This is quite an arbitrary choice but obviously some line of demarcation between known ductile materials such as soft steel and copper and known brittle materials such as cast iron must be made in any rationalizing process. As regards the value of ductility which arbitrarily classifies the ductile and brittle materials, the engineer looks upon this as a safeguard against the effect of stress concentrations. Certain data,[13] although very meager, are available to support this viewpoint. The new ideas regarding ductility which we are now obtaining from previous work of Ludwik[14] and the more recent contributions of MacGregor[15] may help to clarify some of our ideas regarding the importance of ductility values. On certain points engineers are clear. It is generally understood that so-called ductile materials can be made to behave as brittle materials and that the usual sliding failure obtained on such can become substantially a separation failure. It may therefore be in order not to classify materials as brittle or ductile but as Nadai[16] has suggested refer to the brittle or the ductile state of materials.

Aims and Scope of Symposium

It is for the purpose of bringing before the materials engineer the viewpoint of the designing engineer and to allow clarification of certain of the characteristics of the tension test some of which have been mentioned here, that the present Symposium is being organized.

The Symposium will consist of three papers dealing with the more fundamental aspects, the strength features, and the ductility features. The specific titles and authors are as stated below:

1. "The Tension Test," by C. W. MacGregor, Associate Professor of Applied Mechanics, Massachusetts Institute of Technology.
2. "The Strength Features of the Tension Test," by F. B. Seely, Professor and Head, Department of Theoretical and Applied Mechanics, University of Illinois.
3. "The Ductility Features of the Tension Test," by H. W. Gillett, Metallurgist, Battelle Memorial Institute.

It is planned to have the papers preprinted and distributed considerably in advance of the meeting in order that a very complete discussion of each may result. If a better understanding is arrived at of the behavior of materials leading to their better application it will be well worth the effort.

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[10] A safe range of +20,000 psi. to +80,000 psi. was increased to +20,000 psi. to +120,000 psi. by shot blasting has been obtained by Zimmerli.

[11] H. F. Moore and J. B. Kommers, "An Investigation of Fatigue of Metals," *Bulletin 124*, University of Illinois (1921).

[12] This viewpoint is fully discussed in article by B. P. Haigh, "Relative Safety of High Tensile and Alloy Steels Under Alternating and Pulsating Stresses," *Proceedings*, Inst. Automobile Engrs. (1929).

[13] H. Fowler, "Solid Crank Axles," *Engineer*, December 5, 1924.

[14] P. Ludwik, "Bruchgefahr und Materialprüfung," *Bericht 35*, Eidgenössische Materialprüfungsanstalt, Zürich.

[15] C. W. MacGregor, "Relation Between Stress and Reduction in Area for Tensile Test of Metals," *Technical Publication 805*, Am. Inst. Mining and Metallurgical Engrs. (1937).

[16] *Loc. cit.*, Nadai; also *loc. cit.*, Timoshenko.

Burst Test Data on Laminated Glass[a,1]

By W. R. Koch[2] and E. J. Wyrostek[2]

SYNOPSIS

The use of pressure cabins in aircraft for substratosphere flying has necessitated a study of the physical properties of laminated glass over a wide range of temperatures. Burst tests of rectangular plates clamped on all four edges were conducted by means of differential air pressure. The laminated glass used consisted of drawn glass, polished plate glass, heat-treated glass, and combination polished plate and heat-treated glass, of various sizes and thicknesses. The plastics used in laminating included acetate, acrylate, and vinyl resins.

All types of laminated glass were found to require higher burst pressures at temperatures near −30 C. than at those near 20 C. The data indicate that rectangular plates are stronger in burst than square plates of the same area. For an area of 1 sq. ft. a plate having a length-side ratio of four will resist burst at a pressure about twice that which causes fracture of a square plate of the same area. The burst strength of laminated combination glass is essentially the same as that of laminated heat-treated glass. The burst resistance of each of these types is about three times that of laminated polished plate glass. The deflection at the mid-point of laminated polished plate for a given pressure is slightly more than that of either laminated heat-treated glass or laminated combination glass for the same thickness. The deflections of laminated glass containing acrylate or vinyl resin are considerably greater than those containing acetate plastic. The burst pressure data on the glass containing the various plastics do not indicate outstanding burst characteristics for any one particular type of plastic. The data for various sizes do not give the same order of preference and conclusive results can only be obtained from a more extended investigation.

The rate of application of air pressure is an important factor in the results of burst tests. Although in general the rate was varied in such a way as to result in the total time of each test being of approximately the same period, variations in the rate of loading were used on identical glass specimens. The results of these tests indicated that glass is more resistant to burst pressures which are applied rapidly than to constant pressures or to those applied slowly. In the extreme case of a constant low pressure maintained until fracture occurred the necessity for the use of a high factor of safety was demonstrated. In some cases glass under constant pressure fractured after a few minutes at a pressure one-third of that necessary in burst tests conducted in the usual manner. Since a time test at constant pressure simulates the actual use in aircraft it is concluded that such tests are the most significant type for this purpose.

Scatterability characteristics of the glass under burst or impact are also significant, and the unobstructed view of the pilot is a primary consideration in all cases. Because of spalling within the glass it is desirable to limit the thickness of the surface glasses to less than 1/4 in. Glass fractured at pressures less than 25 psi. is usually satisfactory from the standpoint of scatterability. Although vision is somewhat impaired by laminated plate and thin laminated heat-treated glass after fracture due to pressure, it should be emphasized that laminated combination and laminated heat-treated glass of more than 1/4-in. thickness becomes practically opaque after fracture.

GLASS USED in airplane windshields is selected on the basis of its physical properties under the various conditions encountered. Usually we consider the purpose of windshields to be the protection of the airplane occupants from air, but at high altitudes glass also protects the airplane occupants from lack of air. Satisfactory performance of glass in burst tests is therefore essential. The scatterability characteristics of the glass under burst or impact are also important. The optical properties of glass are significant since the unobstructed vision of the pilot is a primary consideration in all cases. Comparisons made in this study are based almost entirely on burst values. The sizes chosen for this investigation represent those sizes most frequently used in airplane windshields and windows. The range of thicknesses selected for test is based on the use of laminated polished plate glass of large areas under atmospheric pressure. Comparative burst data on the other types of glass were obtained for available sizes and thicknesses in order to establish the fundamental relations desirable for design purposes.

[a] Presented at the Forty-second Annual Meeting, Am. Soc. Testing Mats., Atlantic City, N. J., June 26–30, 1939.

[1] Released by Chief, Information Division, U. S. Army Air Corps.

[2] Assistant Physicist and Junior Engineering Aide, respectively, Wright Field, Dayton, Ohio.

MATERIALS

Laminated glass containing cellulose acetate for this investigation was purchased under competitive bid from three of the leading producers. Rectangular specimens

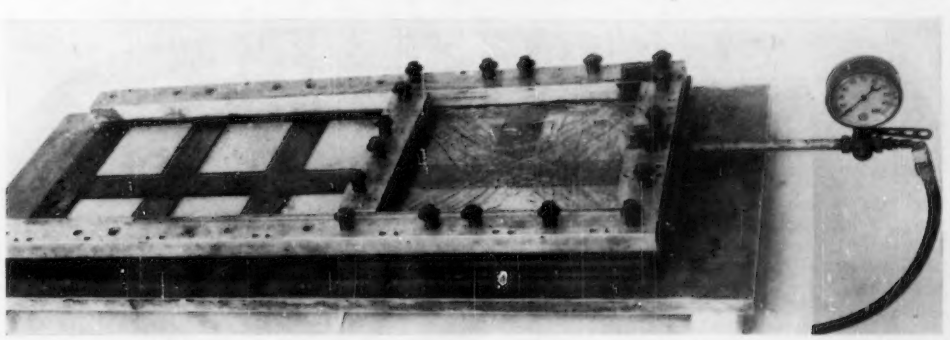

Fig. 1.—Burst Test Apparatus for Glass and Plastics to Be Used in Pressure Cabins.

6 by 6, 6 by 12, 6 by 24, 12 by 12, 12 by 24, and 18 by 18 in. were used in thicknesses of 3/16, 1/4, 1/2, 5/8, 3/4, and 1 in. Further specimens of laminated glass, incorporating recently developed plastics, were submitted gratis by manufacturers for comparative tests. The complete project included laminated drawn glass, laminated polished plate glass, laminated combination (plate and heat-treated) glass, and laminated heat-treated glass. The plastics used were cellulose acetate, acrylic resin, and vinyl resin. The use of these plastics in laminated glass has been described by Sherts.[3]

Test Methods

The burst tests were conducted by subjecting the specimens to differential air pressure after they had been mounted between rubber gaskets in a frame of the type described by Watkins and Wampler.[4] In Fig. 1 the fractured glass is shown bolted between aluminum alloy bars and the aluminum alloy base plate. The design of the base made possible tests on plates of various sizes. Air was used rather than a liquid in order to simulate the actual conditions under which the glass would be used. Necessary precautions for the safety of the observers were taken and the violence accompanying the rupture recorded in relation to scatterability. The air chambers used were of small volumes, none of them exceeding 100 cu. in. A clamping margin of 1/2 in. was used on all four sides of each specimen. Combination glass was placed in the frame in such a way that the heat-treated plate was in the upper position and therefore subjected to tensile stress. The degree of tightening of the edge clamps used was intermediate between that causing cracking of the glass and that allowing leaks in the system. Low pressures were measured by means of a mercury manometer, while those above 15 psi. were determined by means of air pressure gages of appropriate ranges. The deflection of the glass at the midpoint of its upper surface was measured by means of a micrometer dial supported by a tripod. The deflections were measured relative to the surface of the glass at the edge of the clamping margin. Observations were made by means of a telescope.

The rate of application of air pressure or rate of loading was recorded for certain tests although its significance was not appreciated until much of the investigation had been completed. This subject has been discussed by Morey.[5] In general the rate was varied in such a way as to result in the total time of each test being of the same order of magnitude. The extreme case of maintaining a constant low pressure until fracture occurred indicated that a high factor of safety must be used with usual laboratory data.

The low temperature burst tests were conducted in the Materials Branch cold room which has a volume of more than 200 cu. ft. The air pressure was supplied and regulated from the insulated conditioning room which adjoins the cold room. Hence the air supplied to the pressure compartment of the burst-test apparatus was at a

[3] J. H. Sherts, "Laminated Glass," ASTM Bulletin, No. 85, March, 1937, p. 10.

[4] G. B. Watkins and R. W. Wampler, "The Strength of Flat Glass Under Uniform Load," *Bulletin*, Am. Ceramic Soc., Vol. 15, p. 243 (1936).

[5] G. W. Morey, "The Properties of Glass," p. 336, Reinhold Publishing Co., New York, N. Y. (1938).

TABLE I.—BURST DATA FOR 12 BY 12-IN. LAMINATED GLASS CONTAINING VARIOUS PLASTICS.

Type	Plastic Thickness, in., and Type	Thickness, in.		Burst Pressure, psi.	Rate of Application, psi. per min.	Deflection, 10 psi., in.	Deflection, 33 per cent Burst Pressure, in.	Manufacturer
		Nominal	Actual					
Drawn	0.038 Acrylic		0.128	3.7	5	...	0.109	M
	0.038 Acrylic		0.129	3.5	5	...	0.105	
	0.026 Acrylic		0.138	3.5	5	...	0.084	
	0.026 Acrylic		0.139	3.1	5	...	0.077	
	0.026 Acrylic		0.165	3.2	5	...	0.058	
	0.026 Acrylic		0.165	5.1	5		0.080	
	0.022 Acrylic	SS	0.206	3.7	5	...	0.044	
	0.022 Acrylic	SS	0.205	4.6	5	...	0.053	
Plate	0.030 Vinyl	0.250	0.222	3.7	5	...	0.032	L
	0.030 Vinyl	0.250	0.213	5.7	5	...	0.036	
	0.015 Vinyl	0.250	0.220	5.3	5	...	0.041	
	0.015 Vinyl	0.250	0.225	5.7	5	...	0.031	
Heat treated	Vinyl	0.250	0.234	27.1	10	0.132	0.121	K
		0.250	0.228	24.0	10	0.148	0.124	
Combination	Acetate	0.250	0.236	31.0	10	0.058	0.059	
		0.250	0.228	30.0	10	0.054	0.054	
Heat treated	Acetate	0.250	0.229	26.0	10	0.052	0.046	
		0.250	0.240	26.0	10	0.046	0.040	
Plate	Acetate	0.250	0.227	6.6	5	...	0.016	N
		0.250	0.245	6.4	5	...	0.011	
Drawn	0.020 Acrylic	DS	0.236	4.3	5	...	0.031	M
	0.020 Acrylic	DS	0.234	4.3	5	...	0.032	
Plate	Vinyl	0.250	0.238	4.9	5	...	0.028	K
		0.250	0.239	6.0	5	...	0.033	
Plate	0.026 Acrylic	0.250	0.244	7.8	5	...	0.053	M
	0.026 Acrylic	0.250	0.245	5.8	5	...	0.040	
Drawn	0.020 Acrylic	DD	0.267	8.3	5	...	0.044	
	0.020 Acrylic	DD	0.266	11.2	5	0.130	0.056	
Combination	Vinyl	0.375	0.362	53.5	20	0.035	0.062	K
		0.375	0.361	57.5	20	0.036	0.069	
Heat treated	Vinyl	0.375	0.375	60.2	20	0.031	0.064	
		0.375	0.376	62.7	20	0.033	0.069	
Plate	Acetate	0.500	0.485	36.5	10	0.007	0.010	N
		0.500	0.464	31.5	10	0.009	0.009	
Combination	Acetate	0.500	0.532	78.5 CB	10	0.005	0.017	L
		0.500	0.531	91.0 NB	10	0.006	...	
Heat treated	Acetate	0.500	0.534	160.0	20	0.005	0.031	
		0.500	0.535	152.0	20	0.006	0.031	
Plate	Acetate	0.750	0.716	66.1	20	0.003	0.006	
		0.750	0.707	57.3	20	0.003	0.006	
Combination	0.081 Acetate	0.750	0.768	232.0 NB	50	0.003	...	N
	0.081 Acetate	0.750	0.747	200.0 NB	50	0.003	...	
Heat treated	Acetate	0.750	0.807	200.0 NB	50	0.003	...	
Plate	Acetate	1.000	0.953	75.0	40	0.001	0.003	
		1.000	0.934	138.2	40	0.001	0.007	

TABLE II.—BURST DATA ON 12 BY 12-IN. LAMINATED GLASS AT VARIOUS TEMPERATURES.

Type	Plastic Thickness, in., and Type	Nominal Thickness, in.	Low Temperature				Normal Temperature			
			Thickness, Actual, in.	Burst Pressure, psi.	Temperature, deg. Cent.	Rate of Application, psi. per min.	Thickness, Actual, in.	Burst Pressure, psi.	Temperature, deg. Cent.	Rate of Application, psi. per min.
Drawn	0.038 Acrylic		0.122	6.0	−39	10	0.128	3.7	23	5
							0.129	3.5	23	5
Drawn	0.026 Acrylic		0.139	5.5	−39	5	0.138	3.5	25	5
							0.139	3.1	25	5
Drawn	0.026 Acrylic		0.163	9.4	−36	10	0.165	3.2	25	5
							0.165	5.1	25	5
Drawn	0.022 Acrylic	SS	0.207	10.8	−37	10	0.206	3.7	26	5
							0.205	4.6	26	5
Plate	Vinyl	0.250	0.222	15.0	−38	10	0.238	4.9	23	5
		0.250	0.234	15.0	−33	10	0.239	6.0	23	5
Combination	Acetate	0.250	0.232	30.0	−38	20	0.236	31.0	30	10
							0.228	30.0	26	10
Heat treated	Vinyl	0.250	0.229	33.0	−35	20	0.234	27.1	23	10
		0.250	0.235	38.0	−35	40	0.228	24.0	23	10
Drawn	0.020 Acrylic	DS	0.236	12.4	−37	10	0.236	4.3	23	5
	0.020 Acrylic	DS	0.236	18.4	−38	20	0.234	4.3	23	5
Plate	0.015 Vinyl	0.250	0.245	12.2	−38	10	0.220	5.3	26	5
	0.015 Vinyl	0.250	0.235	11.8	−34	20	0.225	5.7	23	5
Heat treated	Acetate	0.250	0.240	32.5	−38	20	0.229	26.0	26	10
							0.240	26.0	26	10
Plate	0.026 Acrylic	0.250	0.243	13.2	−37	10	0.244	7.8	26	5
	0.026 Acrylic	0.250	0.245	14.2	−38	10	0.245	5.8	26	5
	0.030 Vinyl	0.250	0.246	12.8	−36	10	0.222	3.7	23	5
	0.030 Vinyl	0.250	0.255	19.0	−34	20	0.213	5.7	23	5
Drawn	0.020 Acrylic	DD	0.267	11.2	−31	10	0.267	8.3	23	5
	0.020 Acrylic	DD	0.268	11.5	−31	10	0.266	11.2	23	5
Combination	Vinyl	0.375	0.374	87.0	−41	40	0.362	53.5	23	20
	Vinyl						0.361	57.5	23	20

temperature of 5 to 15 C., while the apparatus and the glass were at the low temperatures recorded (−25 to −43 C.) for at least 48 hr. prior to the test. This arrangement simulated the service condition in aircraft at high altitudes except in relation to time.

Test Data

Since results of glass tests are conclusive only when based on data from a large number of specimens of each type, the present study must be considered as a survey based on a limited number of specimens of each type. The relevant data on individual specimens of the 12-in. squares are presented for comparison in order that the conclusions may be considered in relation to the scatter obtained in the data. More than a hundred other specimens were fractured to obtain the data shown graphically.

The test results for laminated glass containing various plastics are given in Table I. The pairs of plates are arranged in order of thickness and therefore approximately in order of weight. The data for rate of application of pressure were estimated for the time immediately preceding rupture. The acetate plastic varied in thickness from 0.025 in. for thin glass to 0.085 in. for thick glass. The notation NB after the pressure indicates that no break occurred, and the notation CB indicates that only the plate in compression (lower side) was fractured. The deflections tabulated are for a pressure of 10 psi. which is considered a usual value to be encountered in aircraft pressure cabins. The deflection at a pressure corresponding to one-third of the burst pressure is also given for comparison purposes. At that value the deflections are still practically proportional to the pressure. All deflection values are in inches.

The comparative results for normal temperature and low temperature are recorded in Table II. After it was determined that the burst pressure at low temperature was greater than that at normal temperature for numerous pairs, the remainder of the tests were made on single specimens.

Table III includes data on several series of similar plates for which the rate of application of pressure was varied. In four cases individual specimens were subjected to pressure gradually increasing at the rate of 6 psi. per min. until an arbitrarily selected pressure of 4 psi. was reached. This pressure was maintained until fracture occurred. In these cases the time which elapsed after the final pressure was obtained until the fracture occurred is recorded with the final pressure.

Discussion of Data

The variation in the burst pressures for similar specimens is relatively large in the data obtained. The factors which contribute to these deviations include glass thickness variation, temperature variation, plastic thickness variation, changes in the rate of application of pressure, and the variation in the degree of edge clamp pressure. The fact that laminated heat-treated and combination glass could be clamped without cracking may be correlated with the fact that the percentage variation in results was less for these types of glass than for laminated polished plate.

TABLE III.—BURST DATA ON 1/4 BY 12 BY 12-IN. LAMINATED PLATE GLASS AT VARIOUS RATES OF APPLICATION OF PRESSURE.

Temperature 18 to 23 C.

Plastic Thickness, in., and Type	Thickness, Actual, in.	Burst Pressure, psi.	Rate of Application, psi. per min.	Manufacturer
Vinyl	0.243	17.5	360	K
Vinyl	0.239	7.5	120	
Vinyl	0.247	10.5	90	
Vinyl	0.240	8.0	15	
Vinyl	0.239	7.0	15	
Vinyl	0.239	6.0	5 (estimate)	
Vinyl	0.238	4.9	5 (estimate)	
0.015 Vinyl	0.221	5.0	120	L
0.015 Vinyl	0.242	7.0	120	
0.015 Vinyl	0.226	4.5	15	
0.015 Vinyl	0.226	4.0	(Broke after 40 sec. at this pressure)	
0.030 Vinyl	0.224	11.0	360	L
0.030 Vinyl	0.240	5.5	15	
0.030 Vinyl	0.222	3.8	5 (estimate)	
0.030 Vinyl	0.243	5.8	5 (estimate)	
0.030 Vinyl	0.245	4.0	(Broke after 20 sec. at this pressure)	
0.026 Acrylic	0.247	11.0	120	M
0.026 Acrylic	0.247	6.0	15	
0.026 Acrylic	0.248	4.0	(Broke after 40 sec. at this pressure)	
Acetate	0.227	6.6	5	N
Acetate	0.245	6.4	5	
Acetate	0.243	4.0	(Broke after 100 sec. at this pressure)	

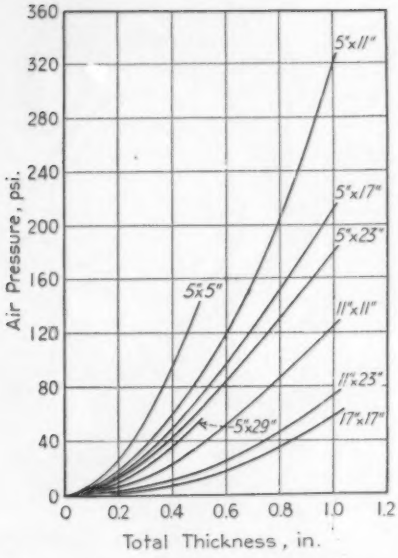

Fig. 2.—Burst Pressure—Thickness Data for Laminated Polished Plate Glass.

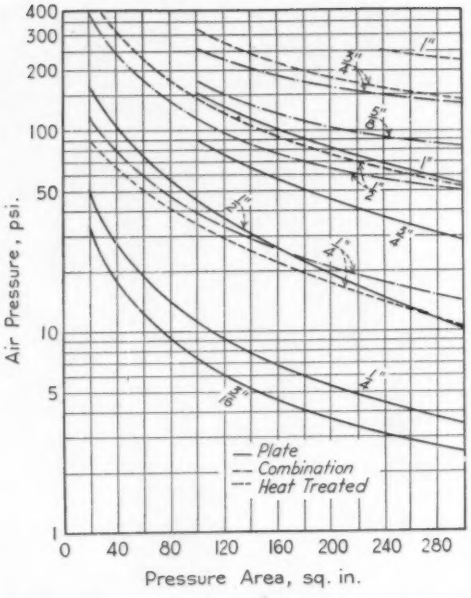

Fig. 3.—Burst Pressure—Area Relation for Square Plates of Laminated Glass.

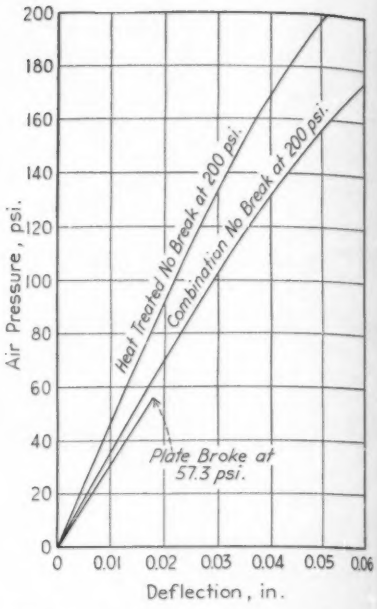

Fig. 4.—Pressure—Deflection Curves for Square Plates of Laminated Glass.

The results obtained for various pressure areas of laminated polished plate glass are represented in Fig. 2. The data were obtained at room temperature on glass containing acetate plastic. The areas given are the actual pressure areas. In all cases specimens were clamped along four edges. The data indicate that rectangular plates having length-side ratios greater than one are stronger in burst than square plates of the same area. For a given area the values of burst pressure obtained for a square plate of a given type and thickness must be multiplied by a form factor greater than unity to obtain the burst pressure of a rectangular plate of equivalent area. For an area of 1 sq. ft. a plate having a length-side ratio of four will withstand a pressure twice that necessary for a plate of the same area. The form factors should be based on ratios of long to short side of numerous specimens covering a wide range of areas.

Data on square plates of the three types of glass containing acetate plastic are shown in Fig. 3. The relative burst strength of laminated heat-treated and combination glass is graphically compared with that of laminated polished plate glass. It should be noted that the curves represent actual burst values and that a suitable safety factor should be used in calculations.

Deflections for similar plates of the three types of glass are shown in Fig. 4. The deflection of laminated polished plate for a given pressure is slightly more than that of either laminated heat-treated glass or laminated combination glass for the same thickness. The data plotted are for plates $^3/_4$ by 12 by 12 in.

Deflections for laminated polished plate glass containing various plastics are represented in Fig. 5. The greater yield of the resins compared to the acetate is apparent. The data plotted are for plates $^1/_4$ by 12 by 12 in. in dimension.

The burst pressure data on the glass containing the various plastics do not indicate outstanding burst characteristics for any one particular type of plastic. The data for various sizes do not give the same order of preference and conclusive results can only be obtained from a more extended investigation. The data for two sizes of laminated polished plate are given in Fig. 6. The curves for glass containing acetate plastic were taken from Fig. 2.

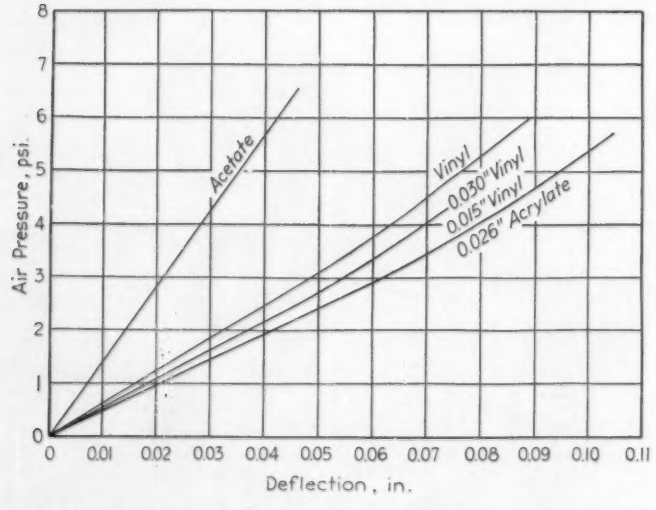

Fig. 5.—Pressure—Deflection Curves for Square Laminated Glass Containing Various Plastics.

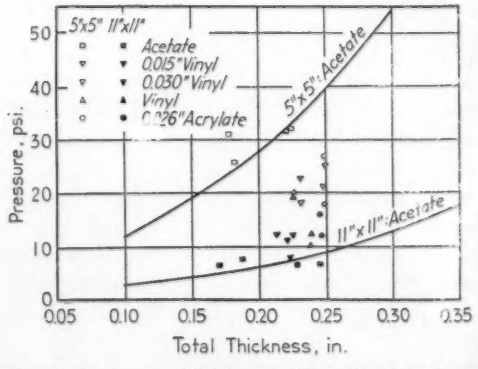

Fig. 6.—Burst Pressure—Thickness Data for Laminated Plate Glass Containing Various Plastics.

Data on scatterability on rupture indicate that the glass fractured at pressures less than 25 psi. is not usually thrown from the frame. The glass scattered in such cases is chipped from the edges of cracks. The amount is negligible for thin glass. Glass having an over-all thickness of 1/2 in. or more is usually quite unsatisfactory from the standpoint of scatterability. Because of spalling within the glass it is considered desirable to limit the thickness of the surface glasses to less than 1/4 in. A greater thickness of glass may be laminated from more than two layers to fulfill strength requirements when necessary.

The adhesion of the various plastics was considered satisfactory in general although a few specimens containing acetate plastic had definitely inferior bond. In several cases the glass containing acrylic resin showed a narrow line of separation of plastic and glass along cracks.

The significant optical property related to burst test is general visibility after fracture. Although vision is somewhat impaired by laminated plate and thin laminated heat-treated glass after fracture due to pressure, it should be emphasized that laminated combination and laminated heat-treated glass of more than 1/4-in. thickness become practically opaque after fracture.

Acknowledgments:

The authors wish to acknowledge the cooperation of the Libbey-Owens-Ford Glass Co., the American Window Glass Co., the Safetee Glass Co., and the Pittsburgh Plate Glass Co. in the supply of glass and information on methods of test.

The work of F. B. Fuller of the Materials Branch in the completion of certain of these tests is also gratefully acknowledged.

DISCUSSION

MR. E. L. HETTINGER.[1]—I should like to inquire whether you have conducted any impact tests.

MR. W. R. KOCH.[2]—Tests now in progress indicate that the newer resins are more resistant to impact than the acetate plastics.

MR. HETTINGER.—We have been carrying on some very interesting experiments along those lines. We first started with the old inner tube with 10 lb. of air, then 20, and finally we got a tank. So the results you secured in laminated glass are quite interesting.

As to the opacity of heat-treated glass, if you would get away from the brittle point and heat treat to the tough point, there would be no opacity in the plate. I believe that Mr. Miller, of the Pittsburgh Plate Glass Co., would be able to give you some information on that, and the tests would stand a great deal more than the brittle glass.

MR. C. L. BABCOCK.[3]—I should like to make a suggestion concerning the gaskets. I believe you had trouble in maintaining the pressure with rubber gaskets?

MR. KOCH.—Yes, we did have.

MR. BABCOCK.—I should like to call attention to a somewhat different technique employed in similar tests by T. C. Poulter[4] of the Armour Institute. He found that it was necessary to put the glass window in direct contact with polished steel surfaces in order to obtain pressures of several thousand atmospheres. He found that glass pressure windows installed with rubber gaskets burst at much lower pressures than those which were placed in direct contact with the polished steel surfaces.

MR. KOCH.—We appreciate these comments from Mr. Hettinger and Mr. Babcock. We did not try any metal contacts, but we are interested to know that data are available which show that the clamping effect gives a different result.

[1] Director of Optical Research Dept., Willson Products, Inc., Reading, Pa.

[2] Assistant Physicist, Wright Field, Dayton, Ohio.

[3] Research Physicist, Owens-Illinois Glass Co., Toledo, Ohio.

[4] T. C. Poulter, "Apparatus for Optical Studies at High Pressure," *The Physical Review*, Vol. 40, pp. 860–871 (1932).

T. C. Poulter and Carl Benz, "Lens Effect of Pressure Window," *The Physical Review*, Vol. 40, pp. 872–876 (1932).

T. C. Poulter and Robert O. Wilson, "Permeability of Glass and Fused Quartz to Ether, Alcohol, and Water at High Pressure," *The Physical Review*, Vol. 40, pp. 877–880 (1932).

T. C. Poulter and Francis Buckley, "Diamond Windows for Withstanding Very High Pressures," *The Physical Review*, Vol. 41, pp. 364–365 (1932).

T. C. Poulter, Carter Ritchey, and Carl Benz, "Effect of Pressure on the Index of Refraction of Paraffin Oil and Glycerine," *The Physical Review*, Vol. 41, pp. 366–367 (1932).

Specifications in Shipbuilding[1]

By Paul Ffield[1]

IT MIGHT be stated that there are two types of material specification. In the one, the specification covers the material, whereas, in the other, the specification may cover a material for a specific purpose. Mr. Ffield's talk covered particularly the latter type of specification. It was pointed out that in order to discuss shipbuilding specifications it is necessary first of all to get the viewpoint of shipbuilders and the people supplying materials to the shipbuilding industry. The general picture of specifications in shipbuilding is somewhat unique. Here we have an industry which is apparently reluctant to take into its sphere new and complex alloys and, consequently, we find the use of alloy steel is overshadowed by enormous tonnages of straight carbon steel.

Even though conservatively simple steels predominate in the shipbuilding industry, specifications are nonetheless written around more complex alloys. However, the

[1] This is an abstract of an interesting talk given by Mr. Ffield, Materials Engineer, Shipbuilding Div., Bethlehem Steel Corp., Quincy, Mass., at the New York District Meeting, December 12.

Fig. 1.

use of alloy steels is confined to specific purposes and comparatively smaller tonnages. Mr. Ffield's talk included a brief résumé of the uses of specialized steels for turbine rotors and turbine blading and other high-temperature applications.

The shipbuilding industry is sometimes taken to task for its apparent reluctance to accept new alloys and materials. There are, however, several differences between the shipbuilding industry and other industries. Ships are probably the largest moving structures made. The stressing conditions in service are certainly unusual and may corporate dynamic loading combined with severe corroding conditions.

In the building of a ship, we encounter fabricating conditions which are somewhat unique and which rely very much on the skill and art of the worker. For instance, in the ship's hull there are often few plates which are flat and rectangular in shape; many consist of odd shapes and various curvatures. Some of these plates must be hand-forged into shape, a process known in shipbuilding as "furnacing." Accurate shaping of such plates may involve considerable heating and reheating and sometimes even local quenching. The material after forming may often be galvanized. In some yards which do not have their own galvanizing equipment a certain amount of hot work is done on the steel in the galvanized condition. While this process cannot always be recommended, the shipbuilder may be forced to fabricate the galvanized steel under such conditions. Shipyards such as Bethlehem's at Fore River, having their own galvanizing equipment, can schedule all the hot work before galvanizing.

Simple operations such as flanging and joggling may become acute since the shipbuilder for certain reasons may require particularly sharp joggles or bends. While a sharp flanging job may be undesirable from the metallurgical viewpoint, it may have structural advantages since it might reduce the eccentric loading in a riveted joint by permitting the rivets to be placed as close to the bend as possible. Slides were shown which indicated the possible magnitude of bending stresses and particularly shearing stresses in joggled and flanged plates.

It was pointed out that material which has been severely deformed by cold work might have its impact strength reduced when the impact loading was of the opposite sign to the fabrication loads. This condition is shown in a simple test where two pieces of rivet rod were severely bent to an angle of about 45 deg. (see Fig. 1.). An attempt was made to open up the bend of the rivet rod to the left of Fig. 1 by hammering. A single blow of the hammer produced the crack half-way through the rivet rod as shown. The rivet rod to the right in Fig. 1 was originally bent the same amount and then opened up statically by squeezing in a vise. In this latter case no cracking occurred though eventually surface tearing of the steel developed. It will be noted that the right-hand specimen has opened up considerably more than the left-hand specimen.

A brief description was given of the welding conditions in the shipbuilding industry. A typical vessel incorporating large amounts of welding is shown in Fig. 2 and it is obviously impracticable to consider in a welded hull any stress relieving other than of subassemblies. It was stated that most welding engineers would agree that in welding such an assembly as a bulkhead, the material should be held flat but should be free to contract. The shipbuilder has found by experience that the so-called drum head method of welding is a very practicable means of eliminating distortion. In the drum head method, the piece is not only held flat but is restricted from contracting. This restriction is obtained by tack welding the bulkhead down to a welding table about its outer periphery. Such welding conditions produce major stresses at points of stress concentration which require a ductile material to yield locally. Often the shipbuilder may be required to fabricate such structures by welding in the galvanized condition, thereby further adding to the metallurgical complications involved.

Mr. Ffield pointed out in conclusion that he did not wish to leave the impression that all shipbuilding work is crude or damaging to the material. He stated that the shipbuilders were in the practical business of building ships and they realized that fabricating conditions were severe from the metallurgical viewpoint and required a material which must not be temperamental but which must be reliable in the extreme to be fabricated successfully. Any reluctance on the part of the shipbuilder to adopt new and complex alloy steels has been based not so much on any criticism of their physical properties but with the realization that to be fabricated economically, these alloy steels must withstand conditions which the metallurgists sponsoring them possibly did not at first sight realize.

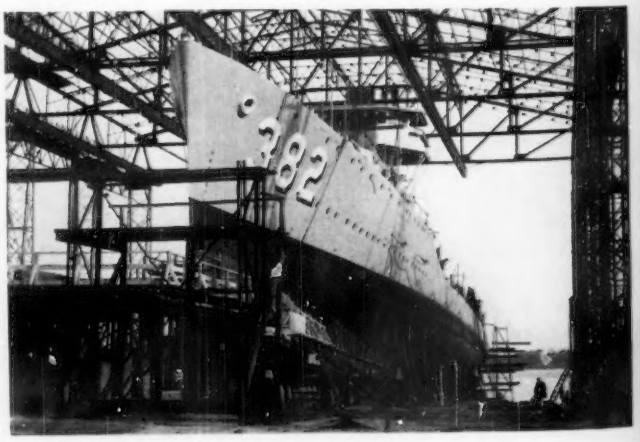

Fig. 2.

Let Us Consider Our Audience

Suggestions as to the Style and Presentation of Technical Papers

By S. Marion Tucker[1]

EDITOR'S NOTE.—This article by Doctor Tucker focuses attention on a subject of great importance—the effective presentation of technical papers. This problem merits the careful consideration of all authors or future authors of technical papers and reports. We are indebted to Doctor Tucker who has done a great deal to stimulate interest in this subject through his writings and lectures.

WHY WE COMPLAIN

THE AGGREGATE number of "papers" read within any one year before more or less bored and bewildered audiences is simply appalling. We have seventy to eighty engineering societies alone, not to speak of the many hundreds of societies of every other imaginable kind. And each meets at least once a year to tell what it has found out since the last meeting. All this is very fine and fortunate, at least in the case of the scientific and technological societies; for if even only one significant discovery, one new truth, one new idea comes out at the meeting, the session has been abundantly justified.

To many of us, not scientists or technologists, it seems that the scientific and technological societies give most by far. What they have to say is often of prime importance directly to human life and to industry, and is perhaps even more important indirectly in its final influence upon social and economic conditions, thus ultimately determining the course of what we like to call civilization. The paper read by that quiet, unpretentious man on the platform may mean the revolutionizing of a great existing industry, the creation of an entirely new industry, the gain of millions of dollars to some persons, the loss of millions to others.

But, lamentably, often it's so hard to know whether or not the paper is important. It's written so badly that the meaning is not clear. Or it's read so badly that we simply can't hear it. Why in the world, we impatiently ask ourselves, can't X., who knows his stuff so well, write clearly? Why, at any rate, can't he at least read his paper well enough to do justice to its immensely important content?

IF ONLY WE WOULD THINK ABOUT THE AUDIENCE

X.'s case is typical, you agree. We *all* agree—we who have sat through innumerable hours of more or less irritation, so often getting little or nothing, when we might as well have been interested or even delighted, had our scientist, or technologist, or teacher, or historian, or what not, have taken the trouble to think a little less about himself and think a lot more about us—his *audience*.

> This one word, AUDIENCE, is the key to the entire matter. There is only one factor that, speaking comparatively, counts when a man gets on a platform to speak or read or do anything else—those persons before him to whom he is supposedly addressing himself, whom he supposedly wishes to understand him, believe him, follow him, accept what he has to say, even think well of him—his *Audience*.

Solomon found three marvels in life that he could not understand—the way of an eagle in the air; the way of a serpent on a rock; and the way of a man with a maid. We must today add two others, even less comprehensible: (1) that a kindly and well-disposed man has the heart to inflict an ill-written and ill-read paper upon an innocent audience; and (2) that the audience, however resentful, suffers in silence.

WHY NOT GIVE A GOOD PAPER THE RIGHT TREATMENT?

The engineer has spent many months, perhaps years, of patient, exact, honest research upon his subject. He now has something of great importance to give us. Since all the really *hard* work has been done, why mar its final effect by stating its results obscurely or clumsily and by presenting them unintelligibly or awkwardly? Why not crown a fine and fruitful effort by giving it the effective style and delivery which it so amply deserves, and thus send it home to just where it belongs—in the minds and quickened sensibilities of the audience?

Well, this engineer is really a humane person; he has pity on people. Furthermore, being sensible and practical, he is not averse to producing a favorable impression both of his message and of his own personality. So he says to himself, "I'll do just that thing. I'll test the business." He does. The results are surprising and eminently gratifying. As soon as our engineer deliberately sets himself to consider his audience, its needs, capacity, and wishes, he writes in a style succinct and condensed, to be sure, but still clear as daylight, easily understood and followed when he reads his paper before the Society. Furthermore, he reads that paper in a voice loud enough to reach *everybody*, and he reads distinctly. He holds himself well, looks at his audience sometimes, puts reasonable animation into his appearance and manner, and really seems to be enjoying himself, not undergoing punishment. Actually, and inevitably, something of his own probably pleasing personality gets into that reading of those cold, unhuman, impersonal scientific facts and makes them take on a degree of human warmth and significance. All of us in his audience are also very human; hence we respond to that reader not only with alacrity but with posi-

[1] Professor of English, and Head, Department of English and Psychology, Polytechnic Institute of Brooklyn. Doctor Tucker's recently published book "Public Speaking for Technical Men" was reviewed in the January ASTM BULLETIN.

tive gratitude. He is a cool, refreshing oasis in the midst of what is sadly often a dry and dusty desert.

Preparation of the Paper: Content and Style

Content.—The paper to be read, no matter how important, must be presented in, say, fifteen or twenty minutes. It is probably the abstract of a much longer paper which has already, or soon will be, printed. Usually, the paper has been referred to several members of the Society who are asked to discuss it. In writing the brief version to be read before the audience, the danger, since time for presentation is so short, is of *too great* condensation—the piling of fact on fact so rapidly and heavily that no one except the experts on this special subject can get much out of the statement. You see, these experts have already *read* it!

One is sorely tempted to recount too many experiments and proofs, instead of stating only absolutely essential things, without repetition of any similar material. Hence:

> *Our first principle in regard to content:* Be brief, condensed, but not to the point of being obscure. State only essentials, but state these fully enough to make them instantly comprehensible. Use a few more of the necessary words and fewer of the unnecessary words.

Style.—By this we mean simply the choice of words and the form of sentences. *The one paramount fact to remember is that the paper is to be read to an audience*—is to be taken in by the *ear*, not by the *eye*. Now, we all know that there is a world of difference between reading something for oneself and hearing it read by another person. When we read for ourselves, we can take as long as we like to study and understand the thing. We can pause and ponder. When, however, we *hear* the thing read, we are simply listening to what is virtually a speech, as far as the auditor is concerned. We must undergo the strain of listening intently, and we must understand instantly or, perhaps, never understand at all. To what inevitable conclusion does this salient fact lead us? Simply this:

> The abstract should be written in as *simple* a style as possible. Words should be familiar and short. Sentences should be short and also should be simple in construction. Long, involved sentences are an offense in a paper or a speech. They unduly complicate the difficulty of getting the meaning quickly and easily.

Unfortunately, and quite unnecessarily, most sentences in our papers are involved in construction, hence cumbersome and heavy, hence often actually obscure in meaning. Not only should sentences be short and simple, but they should use any and all connective words and phrases that can possibly help to show the exact relation between one statement and another. This is essential to clearness. The use of such convenient connectives does indeed increase the number of words, but this cannot be helped. What, after all, is the very first consideration? *Clearness.*

We have a certain member of the A.S.T.M. who seems to have solved for himself and his audiences this problem of effective and appropriate style. His recipe sounds both simple and practicable. *He makes two versions of his paper.* He writes *number one* in the conventional, more or less "literary," style, appropriate for publication, perhaps in the Bulletin, and for reading by another person. Then he translates this first version into version *number two*, using very simple language and sentences so simple and short that they can be uttered easily by the reader and easily followed by the audience. This second, more or less colloquial, version is of course the one that he reads before the Society.

The Presentation of the Paper

Most of us are compelled to agree that the majority of papers presented at our various meetings, including those of pedagogues and clergymen, are so badly *read* as virtually to ruin the effect of whatever they have to say. First of all, *we often actually cannot hear the words.* The man's voice is so low or so weak that it reaches only the first few rows of auditors, only a small fraction of those who are straining to hear it. Sometimes, indeed, it does not reach even the very foremost row. Now, obviously, *the first duty of a reader is to be audible.* Why do we read aloud at all unless we mean to be heard? Most of us can easily be audible if we really want to be. And there is often present that kindly aid, the amplifier. But if there is none and the speaker is not sure that his voice is reaching the very furthest of his auditors, he can easily make sure by asking sincerely and informally, "Will anyone who is seated in the last row please raise his hand if he can't hear me easily?"—or something like that, so as to bring a clear-cut and unambiguous response. This may be undignified, but for once let dignity go hang: *We must be audible!*

Again, sometimes we cannot follow the reading because *the reader's utterance is indistinct.* He mumbles. His voice sticks in his throat instead of issuing clean-cut from his lips. He may indeed roar so loud that his rumbling tones fill the auditorium, but still he will not be understood. Just as every man can speak audibly, so he can speak distinctly, if he will. We know that indistinct utterance is only a form of physical laziness. It is also an affront to the audience. It is unpardonable because it is so wholly unnecessary.

In regard to clear utterance, our A.S.T.M. member is again helpful. He actually practices the reading of his paper, reading it again and again out loud, for audibility, distinct utterance, proper emphasis, and all the rest of it. He sometimes practices on his family or his intimate friends. They may suffer in the process, but we all agree that they suffer in a good cause. The final public audience profits immeasurably by this man's private rehearsals. They really take very little time.

Of course no set reading of a paper can quite take the place of that most effective utterance in public—the extemporaneous speech, when the speaker looks right into the eyes of his audience, makes himself one with it, and

seems to be simply talking with it. Even scientific material the most abstruse and impersonal can be so presented. But

> It is possible for a read paper to approximate the pleasing effect of extemporaneous speech if the reader makes himself reasonably independent of his written statement so that, as he reads, he can occasionally glance at his audience. Indeed, he can easily become so adroit that he seems to be talking rather than reading, especially if he gets into his voice an intimate, informal, conversational tone.

With such practice, the written paper is not so much a handicap, after all. That occasional glance into the eyes of the audience, that conversational tone of voice, and, perhaps, that occasional impromptu remark or comment on the side, mean so much in establishing the contact between reader and audience which is essential to the full effect of any paper read before any audience whatsoever.

Of course there is much more to proper and truly effective reading or speaking than even the right kind of style in writing and the right utterance in reading. There is, for instance, the avoidance of distracting bodily mannerisms by reader or speaker. There is the proper use of facilities such as blackboard, chart, lantern slides, pointer, exhibits. But all this, however important, is another story. There is no room to tell it here.

What We Can Expect

Most of us, whether members of the A.S.T.M. or of any other society, now agree that things should be generally bettered and that they can easily be bettered by taking thought. Ten times as many papers can be presented effectively, with an impression proportionate to their intrinsic importance. Fortunately, to attain this beatific result, we need no special knowledge or training. We do not have to expend much extra time or effort. We need only to practice a simple, sensible, sure-fire technique, easy for any trained mind, and *determine to place ourselves in the shoes of the audience, to see and hear everything from its point of view.* In other words—and this is the crux of the entire matter—**we need only to observe the one principle of effective style and presentation that fundamentally counts, the one that actually embodies and covers all others:** ***The Audience Must Be Considered First.***

Cooperative Study of Quick Methods of Determining Silicon Dioxide, Calcium Oxide, and Magnesium Oxide in Portland Cement[1]

By W. C. Hanna,[2] L. N. Bryant,[2] and T. A. Hicks[2]

Editor's Note.—The complete report, prepared by the three members of the Working Committee on Methods of Chemical Analysis of Committee C-1 on Cement, gives the results detailed in three extensive tables, an abstract of comments from the cooperating laboratories, and a communication from G. E. F. Lundell, Chief, Chemistry Division, National Bureau of Standards, concerning the analysis of sample U(A). Those interested in studying the details of the report should communicate with W. C. Hanna, Chairman of the Working Committee, or J. R. Dwyer, Technical Assistant, Committee C-1, National Bureau of Standards, Washington, D. C.

The purpose of this investigation was to find quick methods of determining silicon dioxide, calcium oxide, and magnesium oxide which could be recommended for adoption by the Society as alternate methods. They were not intended to supersede the present procedures described in the Standard Methods of Chemical Analysis of Portland Cement (C 114 – 39)[3] but, if proved to be accurate and precise enough for the purposes, would effect a saving in the cost of cement testing. A summary of the results of the tests is given in Table I.

Samples

Samples U and V are the same as samples A and B which had been used in our first investigation in 1933–1934. They had already been analyzed by methods which formed the basis of the present standard methods.[3] Sample U(A) had been accurately analyzed by Dr. G. E. F. Lundell's staff at the National Bureau of Standards.

Sample V(B) was used in addition to sample U(A) because the two represented widely different types of cement—one, standard (or general purpose) cement, and the other, low-heat cement.

Sample W(J) was included in the tests on account of its unusually high content of phosphorus pentoxide. There was some question as to whether such a sample could be analyzed by a method in which perchloric acid was used to precipitate and dehydrate silicon dioxide in view of a statement[4] to the effect that phosphorus pentoxide might be partially lost by volatilization from boiling concentrated perchloric acid.

Methods

The first two of the seven methods shown in Table I were not tried in this investigation as they had been

[1] A condensed form of a Report of the Working Committee on Methods of Chemical Analysis presented at the meeting of A.S.T.M. Committee C-1 on Cement, December 1, 1939, Washington, D. C.

[2] W. C. Hanna, Chief Chemist and Chemical Engineer, California Portland Cement Co., Colton, Calif.; L. N. Bryant, Research Engineer, Green Bag Cement Co. of Penna.; T. A. Hicks, General Chemist, Universal Atlas Cement Co.

[3] 1939 Book of A.S.T.M. Standards, Part II, p. 8.

[4] G. E. F. Lundell and J. I. Hoffman, "Outlines of Methods of Chemical Analysis," p. 29.

TABLE I.—SUMMARY OF CHEMICAL DETERMINATIONS EXPRESSED AS PERCENTAGES.

Silicon Dioxide (SiO_2)

Sample U(A)

	Method Ib	IIb	IIIa	IIIb	IVa	IVb	VIa	VIb	VIIa	VIIb
High	21.53	21.17	22.04	21.50	21.44	21.22	21.40	21.36	21.55	21.32
Low	20.98	20.66	20.90	20.04	20.93	20.73	21.04	20.83	21.33	21.03
M	21.19	21.01	21.34	21.07	21.18	20.98	21.27	21.02	21.51	21.23
	(11)	(10)	(14)	(14)	(14)	(14)	(6)	(6)	(7)	(7)
M°	21.16	21.01	21.27	21.14	21.18	20.98	21.27	21.02	21.51	21.23
	(10)	(10)	(11)	(11)	(14)	(14)	(6)	(6)	(7)	(7)
P.E.(±)	0.11	0.10	0.28	0.23	0.11	0.09	0.11	0.11	0.08	0.07
P.E.°(±)	0.09	0.10	0.07	0.06	0.11	0.09	0.11	0.11	0.08	0.07
S	21.20									
M′	21.10	20.95	21.27	21.14	21.18	20.98	21.27	21.02	21.51	21.23
S′	21.14									

Sample V(B)

	Method Ib	IIb	IIIa	IIIb	IVa	IVb	VIa	VIb	VIIa	VIIb
	23.14	22.52	23.32	22.91	22.94	22.72	22.92	22.68	23.14	22.82
	22.20	22.19	22.59	22.27	22.40	22.20	22.42	22.32	22.76	22.50
	22.66	22.40	22.78	22.62	22.60	22.42	22.66	22.47	22.94	22.67
	(11)	(10)	(14)	(14)	(14)	(14)	(5)	(5)	(5)	(5)
	22.66	22.40	22.74	22.64	22.60	22.42	22.66	22.47	22.94	22.67
	(11)	(10)	(13)	(11)	(14)	(14)	(5)	(5)	(5)	(5)
	0.19	0.08	0.13	0.10	0.11	0.10	0.14	0.12	0.11	0.09
	0.19	0.08	0.05	0.04	0.11	0.10	0.14	0.12	0.11	0.09
	22.61	22.36	22.74	22.64	22.60	22.42	22.66	22.47	22.94	22.67

Sample W(J)

	Method IIIa	IIIb	IVa	IVb	VIa	VIb	VIIa	VIIb
	21.83	21.16	21.20	20.93	21.18	20.98	21.29	20.93
	20.84	19.97	20.64	20.51	20.84	20.62	21.07	20.87
	21.15	20.83	20.97	20.70	20.97	20.77	21.20	20.90
	(14)	(14)	(14)	(14)	(4)	(4)	(4)	(4)
	21.06	20.89	21.00	20.70	20.97	20.77	21.20	20.90
	(10)	(13)	(13)	(14)	(4)	(4)	(4)	(4)
	0.17	0.19	0.10	0.08	0.10	0.11	0.06	0.02
	0.03	0.10	0.08	0.08	0.10	0.11	0.06	0.02
	21.06	20.89	21.00	20.70	20.97	20.77	21.20	20.90

Aluminum Oxide and Ferric Oxide ($Al_2O_3 + Fe_2O_3$)

Sample U(A)

	Method Id	IId	IIIc	IIId	IVc	IVd	VIc	VId	VIIc	VIId
High	8.32	8.32	8.44	8.75	8.48	8.75	7.74	8.04	7.61	7.94
Low	7.68	7.60	6.75	7.61	7.29	7.60	7.50	7.62	7.44	7.67
M	7.98	7.91	7.68	7.95	7.71	7.91	7.61	7.85	7.52	7.80
	(11)	(10)	(14)	(14)	(14)	(14)	(5)	(5)	(6)	(6)
M°	7.98	7.91	7.63	7.83	7.65	7.79	7.61	7.85	7.52	7.80
	(11)	(10)	(10)	(12)	(13)	(10)	(5)	(5)	(6)	(6)
P.E.(±)	0.13	0.14	0.25	0.25	0.19	0.30	0.08	0.14	0.05	0.08
P.E.°(±)	0.13	0.14	0.06	0.14	0.12	0.04	0.08	0.14	0.05	0.08
S	7.56									
M′	7.96	7.89	7.63	7.83	7.65	7.79	7.61	7.85	7.52	7.80
S′	7.54									

Sample V(B)

	Method Id	IId	IIIc	IIId	IVc	IVd	VIc	VId	VIIc	VIId
	11.14	11.40	11.23	11.40	10.89	11.19	10.46	10.68	10.34	10.66
	10.32	10.32	9.95	10.26	10.14	10.36	10.18	10.32	10.06	10.32
	10.60	10.63	10.35	10.49	10.38	10.55	10.34	10.54	10.20	10.47
	(11)	(10)	(14)	(14)	(14)	(14)	(5)	(5)	(5)	(5)
	10.55	10.54	10.31	10.42	10.34	10.50	10.34	10.54	10.20	10.47
	(10)	(9)	(12)	(13)	(13)	(13)	(5)	(5)	(5)	(5)
	0.15	0.23	0.19	0.19	0.12	0.14	0.07	0.11	0.07	0.09
	0.10	0.12	0.06	0.08	0.06	0.07	0.07	0.11	0.07	0.09
	10.53	10.52	10.31	10.42	10.34	10.50	10.34	10.54	10.20	10.47

Sample W(J)

	Method IIIc	IIId	IVc	IVd	VIc	VId	VIIc	VIId
	9.70	9.86	9.23	9.56	8.40	8.62	8.43	8.73
	8.05	8.38	8.11	8.44	8.26	8.46	8.08	8.36
	8.45	8.73	8.45	8.73	8.32	8.53	8.23	8.51
	(14)	(14)	(14)	(14)	(4)	(4)	(4)	(4)
	8.22	8.53	8.39	8.59	8.32	8.53	8.23	8.51
	(11)	(11)	(13)	(11)	(4)	(4)	(4)	(4)
	0.27	0.29	0.19	0.20	0.04	0.05	0.10	0.11
	0.09	0.08	0.12	0.07	0.04	0.05	0.10	0.11
	8.22	8.53	8.39	8.59	8.32	8.53	8.23	8.51

Calcium Oxide (CaO)

Sample U(A)

	Method I	II	III	IV
High	63.98	64.34	63.70	64.05
Low	62.95	62.91	62.30	62.79
M	63.40	63.44	63.09	63.27
	(11)	(10)	(14)	(14)
M°	63.40	63.44	63.09	63.27
	(11)	(10)	(14)	(14)
P.E.(±)	0.22	0.28	0.28	0.25
P.E.°(±)	0.22	0.28	0.28	0.25
S	63.21			
M′	63.23	63.27	63.09	63.27
S′	63.04			

Sample V(B)

	Method I	II	III	IV
	59.78	60.30	59.19	59.67
	58.75	58.70	58.40	58.69
	59.28	59.39	58.93	59.03
	(11)	(10)	(14)	(14)
	59.28	59.39	58.97	58.98
	(11)	(10)	(13)	(13)
	0.25	0.32	0.13	0.18
	0.25	0.32	0.09	0.13
	59.16	59.27	58.97	58.98

Sample W(J)

	Method III	IV
	63.30	63.42
	62.11	62.20
	62.81	62.92
	(14)	(14)
	62.81	62.98
	(14)	(13)
	0.25	0.21
	0.25	0.15
	62.81	62.98

Magnesium Oxide (MgO)

Sample U(A)

	Method I	II	III	IV	V
	4.47	4.59	4.24	4.25	4.20
	4.04	4.05	3.72	3.82	3.81
	4.21	4.24	3.98	4.01	4.03
	(11)	(10)	(14)	(14)	(12)
	4.21	4.24	3.98	4.01	4.03
	(11)	(10)	(14)	(14)	(12)
	0.10	0.15	0.08	0.08	0.08
	0.10	0.15	0.08	0.08	0.08
	4.07				
	4.20	4.23	3.98	4.01	4.03
	4.06				

Sample V(B)

	Method I	II	III	IV	V
	3.95	4.06	3.64	3.60	3.60
	3.36	3.22	3.26	3.22	3.25
	3.58	3.60	3.43	3.43	3.42
	(11)	(10)	(14)	(14)	(9)
	3.58	3.60	3.43	3.43	3.42
	(11)	(10)	(14)	(14)	(9)
	0.14	0.17	0.08	0.08	0.07
	0.14	0.17	0.08	0.08	0.07
	3.57	3.59	3.43	3.43	3.42

Sample W(J)

	Method III	IV	V
	4.21	4.10	4.11
	3.63	3.66	3.72
	3.90	3.90	3.94
	(14)	(14)	(10)
	3.90	3.90	3.94
	(14)	(14)	(10)
	0.11	0.09	0.09
	0.11	0.09	0.09
	3.90	3.90	3.94

Loss on Ignition

	Sample U(A) Year 1934	Year 1939	Sample V(B) Year 1934	Year 1939	Sample W(J) Year 1939
	1.05	1.52	1.29	1.57	1.88
	0.73	1.12	1.03	1.34	1.11
	0.96	1.26	1.23	1.43	1.68
	(11)	(14)	(11)	(14)	(14)
	0.97	1.24	1.23	1.43	1.74
	(10)	(13)	(11)	(14)	(12)
	0.06	0.07	0.05	0.04	0.13
	0.04	0.05	0.05	0.04	0.05
	0.94				
	1.24	1.24	1.43	1.43	1.74
	1.21				

Ferric Oxide (Fe_2O_3)

	U(A) 1934	V(B) 1934	W(J) 1939
High	2.38	5.36	
Low	2.07	5.14	
M	2.24	5.24	2.64
	(11)	(11)	(1)
M°	2.24	5.24	
	(11)	(11)	
P.E.(±)	0.06	0.05	
P.E.°(±)	0.06	0.05	
S	2.20		
M′	2.23	5.23	
S′	2.19		

Sulfur Trioxide (SO_3)

	U(A) 1934	V(B) 1934	W(J) 1939
	1.68	2.10	
	1.50	1.70	
	1.62	1.84	1.36
	(11)	(11)	(1)
	1.63	1.81	
	(10)	(10)	
	0.03	0.07	
	0.02	0.04	
	1.68		
	1.63	1.81	
	1.68		

Insoluble Residue

	U(A) 1934	V(B) 1934	W(J) 1939
	0.18	0.17	
	0.03	0.03	
	0.09	0.09	0.46
	(11)	(11)	(1)
	0.08	0.09	
	(10)	(11)	
	0.03	0.03	
	0.02	0.03	
	0.08	0.09	

[a] Not corrected for $Al_2O_3 + Fe_2O_3$ in the SiO_2 residue.
[b] Corrected for $Al_2O_3 + Fe_2O_3$ in the SiO_2 residue.
[c] Not including $Al_2O_3 + Fe_2O_3$ in the SiO_2 residue.
[d] Including $Al_2O_3 + Fe_2O_3$ in the SiO_2 residue.

M = Mean. Chauvenet's Criterion of Doubtful Observations is not used. Numbers in parentheses indicate number of values included.

M° = Mean. Chauvenet's Criterion is used. Numbers in parentheses indicate number of values included.

P.E. = The Probable Error of a Single Observation, as applied to M. Probable Error $= \pm 0.674\sqrt{\Sigma d^2 \div (n-1)}$ where Σd^2 is the sum of the squares of the deviations and n is the number of observations.

P.E.° = The Probable Error of a Single Observation, as applied to M°.

S = Accurate analysis reported by Dr. G. E. F. Lundell, Chief, Division V-B, National Bureau of Standards, October 6, 1934. The analysis was not made by method I but is placed under method I only for convenience in the comparison of results. For an outline of the method actually used, see the progress report of the Working Committee of November 1, 1939.

M′ = The M° means for methods I and II are recalculated on the basis of loss on ignition obtained in 1939. The M′ means for the other methods are the same as the corresponding M° means.

S′ = Recalculated values of S on the basis of average loss on ignition obtained in 1939.

tried in the first investigation sponsored by the working committee in 1933 and 1934.[5] Method I was taken from the U. S. Bureau of Reclamation Specifications 599D and 566 for Boulder Canyon Project and was later adopted in a modified form as Standard Methods C 77 – 37, Sections 11 to 16.[6] In method II silicon dioxide is determined by boiling with perchloric acid as in the later methods IV, VI, and VII instead of double evaporation in hydrochloric acid as in method I, but method II is identical with method I in all other respects and therefore is not considered to be a quick method. In these two methods calcium oxide is precipitated twice as calcium oxalate, ignited, and weighed as calcium oxide, and magnesium oxide is precipitated twice as magnesium ammonium phosphate, ignited, and weighed as magnesium pyrophosphate.

The use of perchloric acid as a dehydrating agent for silicon dioxide was proposed by H. H. Willard and W. E. Cake.[7] It has been used in various modifications by many cement analysts.

The methods tried in this investigation, methods III, IV, V, VI, and VII, are all quick but vary in details in regard to silicon dioxide and magnesium oxide. They are identical in regard to calcium oxide which is precipitated only once as calcium oxalate and titrated with a standardized solution of potassium permanganate.

These five methods are the same in that magnesium oxide is precipitated only once as magnesium ammonium phosphate. In methods III, IV, VI, and VII the precipitate is ignited and weighed as magnesium pyrophosphate, while in method V[8] the precipitate is titrated with a standardized solution of acid.

In method III silicon dioxide is precipitated by digestion in a hot solution of ammonium chloride in concentrated hydrochloric acid according to Edwin E. Maczkowske's procedure.[9] This procedure for the determination of silicon dioxide is applied to method V also.

In methods IV, VI, and VII silicon dioxide is precipitated by boiling with perchloric acid, but the methods differ from each other in some details. The procedure for method IV is similar to that of the earlier method II and may be considered to be the usual procedure used by cement analysts who use perchloric acid. In method VI[10] the acid is evaporated as completely as possible on a fast hot plate without attaining dryness. On the other hand, in method VII[11] the acid is boiled gently and is not boiled at all after the addition of water prior to filtration.

Results

The cooperating laboratories were requested to report silicon dioxide (SiO_2), aluminum oxide and ferric oxide ($Al_2O_3 + Fe_2O_3$), calcium oxide (CaO), and magnesium oxide (MgO) by methods III and IV and magnesium oxide by method V. Other determinations by method V and determinations by methods VI and VII were optional. Loss on ignition was required in order to ascertain its gain in samples U(A) and V(B) over the period of 6 yr. Ferric oxide (Fe_2O_3), sulfur trioxide (SO_3), and insoluble residue have no bearing on the problems of this investigation and thus were not required. Their determinations made in the first investigation are included in the report to make information about the samples more complete. No attempt has been made to develop a method for $Al_2O_3 + Fe_2O_3$ quicker than the standard method (Section 7 of methods C 114 – 39) because the double precipitation of the hydroxides is considered to be essential for accurate results.

For each analysis two determinations of SiO_2 and two determinations of $Al_2O_3 + Fe_2O_3$ are reported, one set before the volatilization of SiO_2 with hydrofluoric acid and the other afterwards because of the possibility that compensating errors may be of such magnitude and constancy that the treatment of the residue of SiO_2 with hydrofluoric acid can be omitted in an alternate method.

As some of the results deviate from the means so much that the deviations can hardly be attributed to the lack of precision in the methods, Chauvenet's Criterion of Doubtful Observations is used as impartial means to reject doubtful results. The M° and P.E.° values, to which the criterion has been applied, are a more reliable guide than the M and P.E. values which are affected by all the results that have been reported.

After the first investigation, at our request Dr. G. E. F. Lundell of the National Bureau of Standards had an accurate analysis made of sample U(A). It is the policy of his division not to use methods specified by others but to use methods which they think will give results that are as close to the true values as possible. Their analysis is given as S in Table I. This analysis and the M° values are recalculated on the basis of the present values for loss on ignition in samples U(A) and V(B) and given as S′ and M′, respectively, so that they may be compared with the recent results.

We have received criticism of the practice of correcting the results of SiO_2 and $Al_2O_3 + Fe_2O_3$ for the small amount of $Al_2O_3 + Fe_2O_3$ found in the main residue of SiO_2 without correcting the results for the small amount of SiO_2 in the main residue of $Al_2O_3 + Fe_2O_3$. Such practice is specified in the A.S.T.M. standard method (Sections 6 and 7 of methods C 114 – 39). It has been argued that SiO_2 and $Al_2O_3 + Fe_2O_3$ should be corrected in the two ways or not at all. On the other hand, it has been stated that the amount of $Al_2O_3 + Fe_2O_3$ in the main residue of SiO_2 is usually appreciable and is easily determined while the amount of SiO_2 in the main residue of $Al_2O_3 + Fe_2O_3$ is smaller and its recovery is difficult and subject to serious error. Two laboratories attacked this problem with a large number of tests. Their results when corrected in the two ways are high for SiO_2 and low for $Al_2O_3 + Fe_2O_3$ as compared with the results obtained by Dr. Lundell's staff.

Of the five methods tried in this investigation, method III (ammonium chloride method) is favored by five laboratories while methods IV, VI, and VII (perchloric

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[5] *Proceedings*, Am. Soc. Testing Mats., Vol. 35, Part I, p. 235 (1935).

[6] Now appears as Sections 6 and 7, and 9 to 13 of Standard Methods C 114 – 39, 1939 Book of A.S.T.M. Standards, Part II, pp. 9 to 12.

[7] *Journal Am. Chem. Soc.*, Vol. 42, p. 2208 (1920).

[8] The volumetric determination of magnesium oxide was proposed by Thomas F. Mullan, Chief Chemist, Riverside Cement Co., in a private communication.

[9] "A Rapid Method for the Determination of Silica in Portland Cement," *Journal of Research*, Nat. Bureau Standards, Vol. 16, No. 6, June, 1936, p. 549 (*Research Paper 891*).

[10] Proposed by Thomas F. Mullan, Chief Chemist, Riverside Cement Co.

[11] Proposed by Roy N. Young, Chemical Engineer, Lehigh Portland Cement Co.

S′ = Recalculated values of S on the basis of average loss on ignition obtained in 1939.

acid methods) are favored by one laboratory each. Five laboratories prefer a gravimetric procedure for the determination of MgO while three prefer the volumetric procedure given in method V.

Discussion of Results

The probable errors (P.E.°) in Table I do not indicate how close the results are to the true values but can be used to show the degrees of precision (or reproducibility of results) of the various methods. Assuming equal accuracy for all methods, the method which gives the smallest probable error may be considered to be the most precise and consequently the best, but if two methods differ very slightly in probable error, one is not necessarily proved beyond reasonable doubt to be better than the other. From the probable errors it may be seen that the quick methods (III, IV, V, VI, and VII) could be good alternate methods. From the viewpoint of precision, method III appears to be the best, especially if the volatilization of the residue of SiO_2 with hydrofluoric acid is omitted.

An alternate method should be as simple and speedy as possible without precision and accuracy being unduly sacrificed. Results by an alternate method, in case of dispute, are subject to a check by a referee method. In the quick methods tested in the investigation where SiO_2 and $Al_2O_3 + Fe_2O_3$ are not corrected for the $Al_2O_3 + Fe_2O_3$ in the residue of SiO_2, the results for SiO_2 are high in most cases. On the other hand, where such corrections are made, all the results for $Al_2O_3 + Fe_2O_3$ are high. One may conclude that the corrections do not improve the precision and accuracy of the methods as a whole and therefore may be omitted.

As in the standard method, phosphorus pentoxide (P_2O_5) is precipitated with $Al_2O_3 + Fe_2O_3$ and counted as such. If any of it is lost by volatilization during the boiling of perchloric acid, the loss will be reflected in the lowering of results for $Al_2O_3 + Fe_2O_3$ and $SiO_2 + Al_2O_3 + Fe_2O_3$. This is illustrated in Table II.

TABLE II.—AVERAGE $SiO_2 + Al_2O_3 + Fe_2O_3$ BY FOUR LABORATORIES.

Sample	P_2O_5, per cent	Method III	Method VI	Difference
U(A)	0.10	28.95	28.84	0.11
V(B)	0.08	33.05	32.93	0.12
W(J)	0.64	29.41	29.29	0.12

The difference is practically the same regardless of the content of P_2O_5. It follows that there can be no objection to the use of perchloric acid as far as P_2O_5 is concerned.

The results of calcium oxide (CaO) obtained by a single precipitation of the oxalate and its titration with a standardized solution of potassium permanganate are reasonably good. Likewise good results of magnesium oxide (MgO) are obtained by precipitating the phosphate once instead of twice. The results are still good where the precipitation is followed by titration with acid instead of ignition.

Recommendation

The working committee recommends the adoption of method III as an A.S.T.M. alternate method for the determination of silicon dioxide (SiO_2), calcium oxide (CaO), and magnesium oxide (MgO) in portland cement. The recommendation is based partly on the results reported by the cooperating laboratories and partly on their comments and preferences. The proposed method is appended to this report.

Cooperating Laboratories

California Portland Cement Co., O. D. Guire, Jr., Analyst.
City of Pasadena, California, Water Department, S. B. Morris, Chief Engineer and Manager, R. W. Stenzel, Chemist.
Green Bag Cement Co. of Pa., L. N. Bryant, Research Engineer.
Lehigh Portland Cement Co., Roy N. Young, Chemical Engineer, W. J. McCoy.
Longhorn Portland Cement Co., Geo. P. Horn, Chief Chemist.
Marquette Cement Manufacturing Co., C. M. Butler, Chemical Engineer.
Missouri Portland Cement Co., J. J. Fox, Chief Operating Chemist.
National Bureau of Standards, Lime and Gypsum Section, Lansing S. Wells, Chief, E. P. Flint.
National Bureau of Standards, Section on Analysis of Cements and Related Materials, F. W. Smithers, Chief, E. E. Maczkowske.
Portland Cement Association, H. F. Gonnerman, Manager of Laboratory, C. L. Ford, Associate Chemist.
Riverside Cement Co., Thomas F. Mullan, Chief Chemist.
Southwestern Portland Cement Co., Osborn, Ohio, J. B. Alexander, Chief Chemist.
Southwestern Portland Cement Co., Victorville, Calif., R. M. Willson, Chief Chemist, C. B. Core, Assistant Chief Chemist.
U. S. Bureau of Reclamation, R. F. Walter, Chief Engineer, S. O. Harper, Acting Chief Engineer.
Universal Atlas Cement Co., Buffington, Ind., D. I. Elder, Research Chemist.
Universal Atlas Cement Co., Northampton, Pa., T. A. Hicks, General Chemist, L. G. Sprague, Chief Chemist.
University of California, Engineering Materials Laboratory, Raymond E. Davis, Consulting Engineer.

Note.—This list does **not** correspond to the order of laboratories in Table I.

PROPOSED METHOD OF CHEMICAL ANALYSIS OF PORTLAND CEMENT[1,2]

Silicon Dioxide[3]

Procedure

1. (*a*) Mix thoroughly 0.5 g. of cement and about 0.5 g. of NH_4Cl in a 50 ml. beaker, cover the beaker with a watch glass, and add cautiously 5 ml. of HCl (sp. gr. 1.19), allowing the acid to run down the lip of the covered beaker. After the chemical action has subsided lift the cover, add 1 or 2 drops of HNO_3 (sp. gr. 1.42), stir the mixture with a glass rod, replace the cover, and set the

[1] The method was accepted as a proposed A.S.T.M. tentative method at the meeting of Committee C-1 on December 1, 1939, subject to committee letter ballot.

[2] Alternate methods. In case of dispute the results obtained according to Sections 6, 11, and 13 of the Standard Methods of Sampling and Testing Portland Cement (A.S.T.M. Designation: C 114 – 39) of the American Society for Testing Materials[4] shall govern.

[3] This procedure, which covers the precipitation of silicon dioxide by treating cement with NH_4Cl and HCl, is based on National Bureau of Standards *Research Paper 891*, by Edwin E. Maczkowske, "A Rapid Method for the Determination of Silica in Portland Cement," *Journal of Research*, Nat. Bureau Standards, Vol. 16, No. 6, June 1936, p. 549.

[4] 1939 Book of A.S.T.M. Standards, Part II, p. 8.

beaker on a water bath for 30 min. (Note.) During this time of digestion stir the contents occasionally and break up any remaining lumps to facilitate the complete decomposition of the cement. Fit a filter paper of medium fineness to a funnel, transfer the precipitate to the filter as completely as possible without dilution, and allow the solution to drain through. Scrub the beaker with a rubber policeman and rinse the beaker and policeman. Wash the filter two or three times with hot diluted HCl (1:99) and then with ten or twelve small portions of hot water, allowing each portion to drain through completely. Reserve the filtrate and washings for the determination of $Al_2O_3 + Fe_2O_3$.

NOTE.—A hot plate may be used instead of a water bath if the heat is so regulated as to approximate that of a water bath.

(*b*). Transfer the filter paper and residue to a weighed platinum crucible, dry, and ignite, at first slowly until the carbon of the paper is completely consumed without flaming and finally at 1050 to 1100 C. for 1 hr. Weigh the residue as SiO_2.

ALUMINUM OXIDE AND FERRIC OXIDE

Procedure

2. Determine $Al_2O_3 + Fe_2O_3$ by the procedure described in Section 7 of the Standard Methods of Sampling and Testing Portland Cement (A.S.T.M. Designation: C 114 – 39) of the American Society for Testing Materials.[4]

CALCIUM OXIDE

Special Solution Required

3. *Standard Potassium Permanganate (approximately 0.18 N).*—Prepare a solution of $KMnO_4$ on the basis of 5.634 g. per liter. The solution should not be filtered through any filter containing organic matter. It is most convenient to siphon off clear solution without disturbing the sediment on the bottom of the bottle. Standardize the solution with 0.75 g. of sodium oxalate oxidimetric standard furnished by the National Bureau of Standards (standard sample No. 40) according to the directions furnished with the sodium oxalate. If the burette reading is 62.77 ml., the solution contains 0.005634 g. of $KMnO_4$ per milliliter which is equivalent to exactly 0.005 g. of CaO. Because of impurities and deterioration, the reading in the standardization is not usually 62.77 ml. Calculate the value of the solution in terms of weight of CaO per milliliter as follows:

$$E = \frac{62.77 \times 0.005 \text{ g. per ml.}}{a}$$

where:

E = CaO equivalent of the solution in grams per milliliter, and
a = milliliters of solution required for standardization.

Procedure

4. Add a few drops of NH_4OH to the combined filtrates obtained in the aluminum oxide and ferric oxide precipitation and bring the solution to boiling. Add to the boiling solution 25 ml. of boiling ammonium oxalate (5 per cent), and continue the boiling for 5 to 10 min. Then allow the solution to stand for 15 to 20 min. Filter, and wash the precipitate 8 to 10 times with hot water, the total amount of water used in rinsing the beaker and washing not to exceed 75 ml. Wash the precipitate back into the original beaker and add 200 ml. of water and 10 ml. of diluted H_2SO_4 (1:1). Heat the solution just short of boiling and titrate it with the standard solution of $KMnO_4$ to a permanent pink color. Add the filter paper and break it up. Continue the titration slowly until the pink color is permanent for 10 sec. Calculate the percentage of CaO in the cement as follows:

$$\text{CaO, per cent} = b \times E \times 200$$

where:

b = milliliters of solution required for titration, and
E = CaO equivalent of the solution in grams per milliliter.

MAGNESIUM OXIDE

Procedure

5. Acidify the filtrate from the determination of CaO with HCl and by boiling reduce the volume to about 250 ml. When the solution is cooled to room temperature, treat it with 10 ml. of a solution of $(NH_4)_2HPO_4$ (10 per cent) and 30 ml. of NH_4OH (sp.gr. 0.90). Stir the solution vigorously during the addition of NH_4OH and then for 10 to 15 min. longer. Let the solution stand for at least 8 hr. in a cool atmosphere, then filter. Wash the residue 5 or 6 times with diluted NH_4OH (1:20). Ignite it in a tared crucible, at first slowly until the filter paper is charred and then burned off, and finally at 1050 to 1100 C. for 30 to 45 min. Weigh the residue as $Mg_2P_2O_7$ and calculate the percentage of MgO as follows:

$$\text{MgO, per cent} = W \times 72.4$$

where W = weight of $Mg_2P_2O_7$.

BLANK DETERMINATION

Procedure

6. Make a blank determination for silicon dioxide, aluminum oxide and ferric oxide, calcium oxide (Note), and magnesium oxide, using the same procedures as described in Sections 1, 4, and 5, and using approximately the same amounts of reagents. Correct accordingly the results previously determined.

NOTE.—When the amount of calcium oxalate is very small, its oxidation by $KMnO_4$ is slow to start. Before the titration, add a little $MnSO_4$ to the solution to catalyze the reaction.

1940 GOLF TOURNAMENT

Completion of Assignment of Sectional Committee on the Classification of Coals

ADOPTION OF definitions for varieties of coal in the past year completes the assignment given to the Sectional Committee on Classification of Coals. This committee was organized in 1927 under the rules of the American Standards Association. Its scope covered "The classification of all coals from anthracite to lignite, to be based on such chemical and physical characteristics as will make the plan most readily adaptable to industrial and commercial use on a national scale."

In cooperation with an Associate Committee on Coal Classification and Analysis of the National Research Council of Canada a comprehensive program of fact finding and research with reference to North American coals was conducted. Previously proposed systems of classification were critically examined and their application to the wide variety of North American coals was considered. From these studies the committee recommended specifications for the classification of coals (1) by rank, that is, according to the degree of metamorphism, or progressive alteration in the natural series from lignite to anthracite; (2) by grade, that is, according to the nature and amount of impurities present, screen size, analysis, heating value, etc.; and (3) by varieties such as common banded, splint, cannel, and boghead or algal coals.

The classification by rank, which was adopted as tentative in 1934 and as standard in 1937 (A.S.T.M. Designation: D 388), has come into general use by Governmental agencies in classifying American coals and is progressing in commercial usage. The classification by grade (D 389) was adopted as standard in 1937 and the definitions for varieties of coal (D 493) in 1939.

The Sectional Committee, having completed its duty, is recommending that it be discontinued, further revisions in classification to be made by A.S.T.M. Committee D-5 on Coal and Coke. A subcommittee on classification will be organized.

1940 Review of the Inter-Society Color Council

BECAUSE OF the interest of a number of committees of the Society in color and related problems, the Society participates in the work of the Inter-Society Color Council as a member body and has four official representatives: namely, M. Rea Paul, *chairman*, C. E. Foss, A. W. Kenney, and W. M. Scott.

This group has recently submitted its annual report to A.S.T.M. on the Color Council and since this brief review should be of interest to a number of members it is published here:

A 1940 REVIEW OF THE INTER-SOCIETY COLOR COUNCIL

The Inter-Society Color Council is now in its tenth year. At the present time, the Council represents the greatest concentration of color interests ever brought together in this country. It has been active in publishing several hundred pages of technical and informative matter, in addition to the regular reports of meetings and business of the Council. These publications have been furnished to all delegates.

The I. S. C. C. News Letter has continued and expanded its function of informing the membership of the work of the Council. To this has been added information from a variety of sources concerning color. Plans have been made to increase the number of News Letters to six, for the coming year.

Recently one of the major problems undertaken by the Council was concluded. This involved the development of a simplified method of designating colors. A primary concern of the Council during the coming year will be the exploration of further applications of this method that has been recommended for the description of drugs and chemicals. The Council hopes to encourage the use of this method wherever it is appropriate, and discourage attempts to inappropriately employ it. The question of the adaptability of this method of designating colors to other fields will require the advice of every member-body. It is planned to appoint a committee charged with the duty of carrying on the necessary investigation.

A survey is being made of color terms that have been adopted as standard by the different member-bodies. These include the fields of textiles, ceramics, paint, lighting, psychology, pharmaceuticals, and paper. In its present form, the color-term survey is incomplete, but may indicate the need for establishing a more uniform terminology in the field of color.

The technical papers presented at the 1938 and 1939 meetings have been published, and afford a permanent record of accomplishment. There are several results other than those that appear in literary form, such as the I. C. I. charts which were sponsored by the Council during the past year. In addition, two bibliofilms have been made available. These are a "Color Bibliography" and a "Munsell Color Diary."

Contact has been maintained with the local color groups at Washington, Boston, and Chicago, while the individual members of the Council have, during the past year, established a New York group.

The growth in membership of the Council is indicative of its success in attracting more people having various color interests. As of January 1, 1938, the Council consisted of eight national societies, with a representation of forty-four delegates and thirty-two individual members. The present roster includes seventy-four delegates from eleven member-bodies and sixty individual members.

The dissemination of information about instruments for the measurement of color, colored materials, and light sources is to be continued.

A joint session is planned with the Illuminating Engineering Society at its meeting next September, in Spring Lake, N. J. Joint sessions with other member-bodies will be planned.

Perhaps of even more value than the joint sessions themselves is the permanent record of the technical papers that are presented. These papers are published in the journal of the sponsor body.

From a review of the interests of the different societies and associations that compose this Council, it is believed that of first importance is the matter of detecting small color differences. Various aspects of this problem have been discussed. Tests for suitable observers, specifications for suitable light sources, methods of describing the amount and character of the differences, instrumental substitutes for visual inspection, development of recognized tolerances for specific uses of specific materials, are all possible subjects for Council action during the coming year.

SOCIETY APPOINTMENTS

Announcement is made of the following Society appointments:

J. D. SULLIVAN, Battelle Memorial Institute, as an additional Society representative on the Joint Committee on Foundry Refractories.

R. P. MILLER, Consulting Engineer, New York City, as representative, and R. E. HESS, Assistant Secretary, A.S.T.M., as alternate, on A.S.A. Building Code Correlating Committee (reappointments).

C. H. GREENALL, Bell Telephone Laboratories, Inc., Chairman of Committee B-5 on Copper and Copper Alloys, Cast and Wrought, has succeeded C. H. Mathewson, Yale University, former chairman, as one of the Society's representatives on the S.A.E. Non-Ferrous Metals Division.

E. F. GREEN, Metallurgist, Axelson Manufacturing Co., as a member of the Southern California District Committee.

An Electric Furnace for the Determination of the Softening Temperature of Coal Ash

By H. L. Brunjes[1]

THIS PAPER describes a furnace especially adapted for the determination of the softening temperature of ash of coal and coke.

An important feature is the provision for maintaining a *definite* atmosphere of the proper ratio of oxidizing to reducing gases throughout the *entire* testing range.

Capable of operating to 2800 F., the temperature increase can be easily and accurately controlled well within the specified limits at any point in the range. A zone of uniform heat surrounds both the thermocouple and the test cones.

Fig. 1.—Baker Electric Furnace.

Electrically operated, it is absolutely noiseless and without products of combustion; it is economical in power requirements with a consumption of approximately 800 watts.

Five standard-size ash cones are accommodated. Work capacity is increased by reason of the rapid cooling rate, from 2800 F. to 1800 F. in about 20 min. (a new batch can then be inserted without discomfort).

In the Society's procedure for the determination of the softening temperature of coal and coke ash,[2] there are two essential requirements that are often difficult of attainment in certain types of gas-fired furnaces used for this purpose. These are maintenance of the proper ratio between oxidizing and reducing gases in the atmosphere surrounding the cones and definite control of the heating rate within narrow limits. That neglect to conform strictly to these conditions is a frequent and serious source of error, and is too well known among those familiar with the test to comment upon here. For these and other reasons, this paper is presented describing a furnace, commercially available, that will comply fully with all the requirements of the present standard procedure for the determination of the melting characteristics of coal ash.

With the cooperation of Baker and Co., it was found possible, with some minor modifications, to adapt a stock furnace that has been in use for high-temperature work for a number of years. This furnace, shown in Fig. 1, is an unusually compact and self-contained unit, manufactured integrally with a rheostat for heating control and a millivoltmeter with platinum and platinum-rhodium thermocouple for temperature measurements. The unit occupies little space, being 10 by 6 in., and is easily portable.

The muffle, *M*, Fig. 2, is $4^1/_2$ in. long, the platinum-rhodium alloy resistor wire being wound over 4 in. of this length. The back of the muffle consists of a chamber, *B*, into which the required gas mixture is led through tube *A;* on the heating side, the chamber wall is perforated with a number of small openings, *C*, to insure an even distribution of the gases around the ash cones. This wall also serves the purpose of providing a contrasting surface for better observations of the cone, due to the passage of the relatively cool gas through the chamber. The plug door penetrates to a depth of 1 in., leaving a space of $2^1/_2$ in. for placing the cone plaque. The temperature in this zone is very uniform

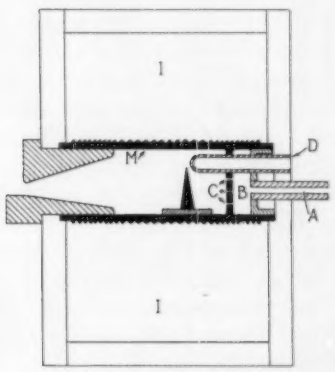


Fig. 2.

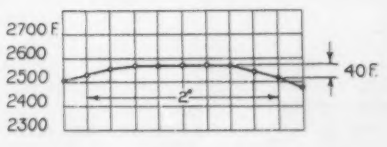


Fig. 3.

[1] Fuel Technologist, Fuel Engineering Co. of New York, New York, N. Y.

[2] Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (D 271 – 37), 1939 Book of A.S.T.M. Standards, Part III, p. 15.

as will be seen by reference to Fig. 3. The entire muffle is surrounded by a circular insulating jacket, *I*.

Observations are made through a 1/4-in. round, tapered opening in the plug door, so that, when the plaque is placed directly under the thermocouple, the cones are easily visible. The opening in the door is covered by a small piece of Pyrex glass, held in place by a spring clip. So little heat is radiated that the eye can be brought within 1 in. or so of the sight hole without discomfort. For rendering the cones more distinct, it has been found helpful to use a green filter, similar to Wratten No. X-2, up to 2500 F., and a green glass, such as used by welders, for the higher temperature ranges.

The heating rate is controlled by a 12.5-ohm rheostat mounted below the muffle which has a graduated dial that can be used as a setting for different rates of temperature increase. This permits the operator some freedom from constant attention, which is necessary on gas-fired furnaces where close watch must be kept on the control of gas and air mixtures. The rate can be adjusted accurately and without difficulty within the required limits throughout the entire critical range, 1500 to 2800 F., which is something not readily accomplished with certain types of gas furnaces, where the rate is apt to be too rapid in the lower part of the range and too slow in the upper. The power consumption of this furnace is very low, considering the temperatures attained, averaging about 800 watts; operating off a 110-v. lighting circuit. Temperatures are determined by the usual type of platinum and platinum-rhodium thermocouple and indicated on a pyrometer, located above the rear of the unit convenient to the observer.

That the maintenance of the proper atmosphere in which the ash cones are heated is a most essential condition of the test, has been thoroughly demonstrated by the fundamental work of Fieldner, Hall, and Feild.[3] This investigation pointed out the limits of oxidizing reducing gas ratios in which the test was to be made and stressed the fact that deviations outside these limits caused serious errors. While the permissible ratios are rather wide, the preferable balance is stated to be 60 per cent oxidizing and 40 per cent reducing; of the reducing gases, at least 40 per cent shall be hydrogen. In our work, to adapt an electric furnace for this test, particular attention was paid to the point of finding a gas mixture rapid and certain in its action, and conveniently available. Trials were made with illuminating gas (coke oven and carburetted water gas) mixed in various proportions with carbon dioxide and nitrogen. These were found to be rather unsatisfactory in several respects and required the use of a somewhat cumbersome gas holder. The use of the products of combustion of a bunsen burner was suggested, but this seemed a somewhat uncertain way to satisfy a requirement of such importance. During these trials, it was found that a bottled gas, obtained in small high-pressure cylinders, answered the requirements. Among those tried, the most satisfactory found was a mixture composed of 60 per cent carbon dioxide, 20 per cent methane, and 20 per cent hydrogen. This has proven to be rapid and certain in its action on the iron in the ash. In the testing procedure, the gas is passed through the muffle at about 50 ml. per min. until the temperature reaches 1400 F. The rate is then increased to about 150 ml. for the next 500 F.; the flow can then be slowed down to about 75 or 100 ml. for the remainder of the run. The mixture, as obtained by us, is furnished in cylinders of about 4 by 25 in. under 1000-lb. pressure, and is generally sufficient for 75 to 100 runs. In the use of this gas, over a period of 2 yr., we have not found a single instance of the marked variations in duplicate runs, such as were frequently encountered in the use of a pot-type gas-fired furnace unit.

In the operation of a furnace of this type, under these carefully controlled conditions that answer fully all requirements of the standard, it would be natural to expect that, barring observational errors, each test would be as precise and accurate a determination as it is possible to make under the established procedure. However, as certain furnaces have been considered standard pieces of equipment for years, comparative runs were made using a Melters No. 3 unit. (In these tests particular attention was given to the gas furnace to insure as near an ideal condition as possible for both atmosphere and heating rate.) The results of these runs are given in Table I. Samples marked X-1, 2, 3, 4, 5, 6, 7, and 8 were obtained from the laboratory of a coal-producing company, whose tests were made in a tube furnace, similar to that described by Barrett.[4] In these comparative tests, greater attention was paid to getting several determinations on those ashes fusing in the lower range, 1900 to 2300 F., where ideal conditions on the gas-fired furnaces are most difficult to maintain. Examination of these data indicates

TABLE I.

Sample	Baker Electric Furnace	Standard Gas-fired Furnace
573	2000	2140
	1990	2050
	2000	2015
	2000	2070
969	1970	1960
	1960	2080
	1960	1945
C	2180	2300
	2190	2240
	2190	2260
E	2230	2240
	2240	2260
	2290	2280
M	2360	2400
	2360	2380
	2370	2360
K	2440	2500
	2460	2480
M-1	2460	2500
616	2470	2480
975	2500	2480
K-1	2660	2640
007	2640	2640
043	2640	2620
A	2680	2660
006	2720	2740
042	2740	2760
X-1	2100	2120
X-2	2160	2230
X-3	2680	2750
X-4	2160	2220
X-5	2460	2420
X-6	2420	2450
X-7	2160	2140
X-8	2090	2100

[3] A. C. Fieldner, A. E. Hall, and A. L. Feild, "The Fusibility of Coal Ash and the Determination of the Softening Temperature," *Bulletin 129*, U. S. Bureau of Mines (1918).

[4] Elliott P. Barrett, "A Furnace for the Measurement of Coal-Ash Softening Temperature," *Proceedings*, Am. Soc. Testing Mats., Vol. 35, Part II, p. 627 (1935).

to us very favorable agreement. There is, however, a significant tendency, pointed out by these determinations, for the electric furnace to show slightly lower fusing points, particularly in the 1900 to 2200 F. range. This might be considered the result of having a uniform atmosphere of the proper composition at all times. From the work of Fieldner, Hall, and Feild already referred to, errors due to poor control of the atmosphere are apt to be on the high side, while difficulty in slowing down the heating rate would also tend to give high values.

While it is possible to attain temperatures close to 3000 F., with this furnace, we have not found it feasible to operate above 2800 F., as the life of the winding is shortened considerably by higher temperatures. For many years, it has been our practice to report these higher softening points as 2800 F.+, which answers nearly all purposes in judging coals by this characteristic. We have observed a number of laboratories, both industrial and commercial, in recent years following this plan.

As this type furnace has been in operation in our laboratory for only two years, not a great deal of experience has been had regarding the probable life of the winding. Two experimental furnaces, used in the development work, are hardly fair examples of what might be expected, as efforts were made to subject them to higher than average temperature range. Both had about 70 hr. operating time between 1500 and 2800 F. In each run, the furnace temperature was raised to a top temperature of 2800 F. This is a more rigorous treatment than they would get in ordinary usage. The furnace now in operation, under normal conditions, has had over 300 hr. operating time, with an average top temperature of close to 2750 F. Replacements are easily made by lifting the muffle and surrounding insulating jacket from the frame and inserting an entirely new unit. The old muffle and jacket is returned for reclamation of the winding; as some 95 per cent of the metal is recovered, the replacement cost is moderate.

Eighth American Scientific Congress

THE EIGHTH American Scientific Congress which will be held in Washington, D. C., May 10 to 18, will be of interest to many members of the Society. The Congress, to be organized in eleven sections, has for its chief purposes: To advance scientific thought and achievement; to assist in celebrating the fiftieth anniversary of the founding of the Pan American Union. A formal announcement of the Congress points out that there are also present the basic purposes of all inter-American meetings, namely, the examination of problems peculiar to this hemisphere and the promotion of better understanding among the American republics.

The Organizing Committee in charge of the Congress, headed by Sumner Welles, Under-Secretary of State, includes a number of distinguished American scientists, including Dr. L. J. Briggs, Director, National Bureau of Standards, who is Chairman of Section VI on Physical and Chemical Sciences which will probably be of particular interest to A.S.T.M. members. A statement concerning this section appearing in the Congress announcement is as follows:

"In the program of this Section it is proposed to have a series of papers summarizing the state of development of research in physics and chemistry and the efforts which are being made to apply those sciences in the industrial life of the various American countries. It is known that the governments of several countries have established, or are planning to establish, national standardizing and research laboratories. The Congress will give an opportunity to exchange information regarding the purpose, equipment and management of such laboratories.

"Research in physics and chemistry is also carried on as an adjunct to education in many universities. Papers will be invited summarizing such activities, both as a source of new knowledge and as a means of training students for work in educational, industrial, and governmental laboratories.

"An effort will be made to obtain special papers on applications of physics and chemistry to problems which are of common interest to several of the American republics, such as location and utilization of petroleum, transportation of fruits and meats, testing and purification of sugar, and determination of quality of textiles."

The Secretary of the Organizing Committee is Dr. Alexander Wetmore, Assistant Secretary of the Smithsonian Institution, Washington, D. C. Further details can be obtained by writing to him. Registration is to be at Congress Headquarters at the Pan American Union and forms will be issued upon request. There is no registration fee.

Discussion of Transportation Symposium

MEMBERS OF the Society and others who wish to submit written discussion of the papers comprising the Symposium on New Materials in Transportation (see page 8) held as the technical feature of the Detroit Spring Meeting of the Society, are requested to submit copies of their discussion in duplicate as soon as possible. Committee E-6 on Papers and Publications has set April 20 as the closing date. It is expected that this symposium will be issued in the next few months in the form of a special publication including the papers and discussion. Further announcement concerning this will be made later.

1939 *Proceedings* Distributed

PRESS WORK has been completed on the 1939 *Proceedings* which this year in line with the new scheme of publications are issued in one volume rather than two as heretofore and will contain both committee reports and technical papers. Distribution of the book is now being made and each member should receive his *Proceedings* by the first week in April.

The book this year will aggregate about 1350 pages. Each individual, company, and organization affiliated with the Society receives a copy of this book. Extra copies can be purchased by members at the special price of $6, the list price being $9 each.

AMERICAN SOCIETY FOR TESTING MATERIALS

ASTM BULLETIN

NO. 103 MARCH, 1940

Sixty-three Hundred Pages

TUCKED AWAY in the January BULLETIN article giving a review and preview of Society activities was a statement that "the number of pages in regular publications that will have been issued in 1939 is the largest the Society has ever issued, comprising some 6292, compared with the previous high in 1936 of 5329." The curve of the number of pages in regular A.S.T.M. publications has sharp peaks every three years coincident with the appearance of the Book of Standards, but even in 1937 and 1938 the figure was over 3000.

It is not our purpose to dwell on the mere number of pages, although admittedly this does provide a yardstick of one of the services of the Society. What is more important is the value of the material that is represented. More and more, reports and papers are condensed so as to present the meat. And the standards, too, are ever being placed under more careful scrutiny so as to weed out any that are non-essential or not used by industry, leaving only those that are of real service.

But of equal significance is the fact that there is no diminution of the amount of material that the Society is asked to publish. More investigative work is brought to the Society with the request for publication of the results. The ever-increasing number of standing committees is bringing its quota of new standards in all fields. The way material is developing, with the *Proceedings*, BULLETIN, Supplements, and other items getting larger, members can look forward to no diminution in the amount of the material they will receive.

A.S.T.M. in Textbooks

THE USE of A.S.T.M. specifications and tests either by reference, abstracting, or reprinting in textbooks and other publications used in engineering schools is not new, but the appearance recently of several such books dealing with engineering and construction materials, physical metallurgy, etc., focuses attention on this interesting use of A.S.T.M. standards.

Many authors apparently have found helpful the tremendous growth in the number of A.S.T.M. standards covering materials in widely diversified fields, judging from the extensive use of both the specifications and tests, for they provide *authoritative* information on properties and tests of materials.

In the Book of Standards is a vast store of sound technical information and data on many materials and subjects. It is not strange that writers of texts should find a great deal of this information helpful in connection with engineering education. It would be strange if the information were not helpful.

While the information incorporated in a standard and the properties specified for materials may not represent the ultimate possibilities that can be developed they certainly do indicate without question just what can be expected commercially from the particular item, and that is safe information to give future engineers.

1940 Nominating Committee

AFTER REVIEWING the report of the tellers, J. F. Vogdes, Materials Engineer, Philadelphia School District, The Board of Public Education, and R. B. Lewis, Chief Engineer, Tinius Olsen Testing Machine Co., Philadelphia, Pa., on the recommendations of members for appointments on the 1940 Nominating Committee, the Executive Committee at its January meeting selected members of the committee. A meeting of the Nominating Committee was held in Philadelphia on March 1 with the following designated members present:

A. G. Ashcroft	W. E. Emley
H. F. Clemmer	L. P. McAllister
Sabin Crocker	E. E. Thum

Past-presidents A. C. Fieldner and T. G. Delbridge were also present as *ex-officio* members of the Nominating Committee in accordance with the By-laws which provide that it shall include the three last past-presidents. (Past-president A. E. White on sabbatical leave from the University of Michigan was unable to attend the meeting.)

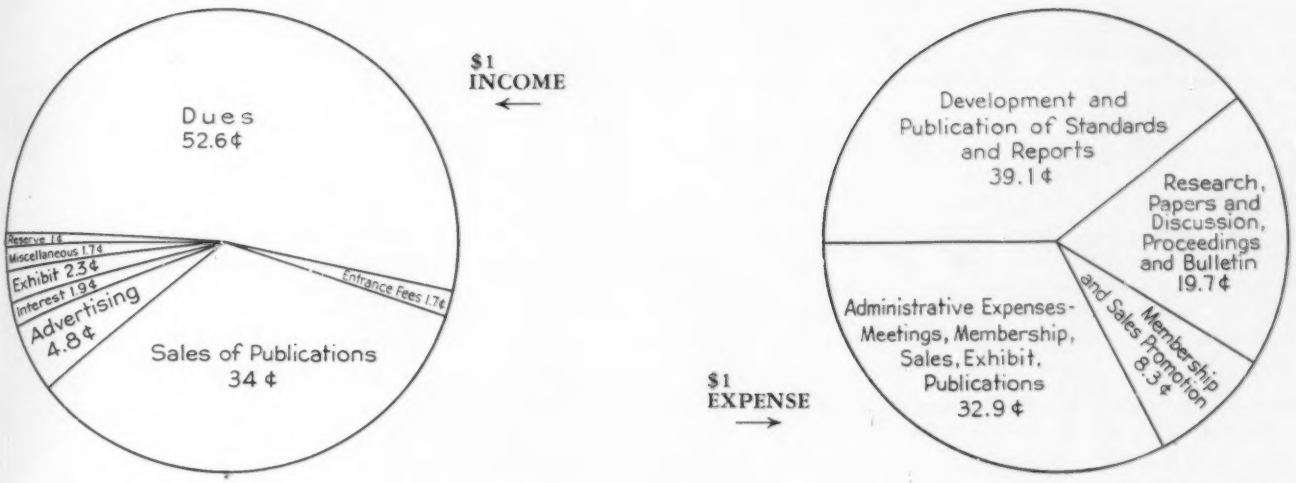
Following the established procedure, the nominees for president, vice-president, and five new members of the Executive Committee will be announced in the May BULLETIN.

Notes on Society Finances

THE SECRETARY-TREASURER's annual report to the Executive Committee on 1939 finances contains some interesting information on the year's operations.

The total operating (budgeted) receipts for 1939 were $150,167, comprising $82,349 from dues and entrance fees, $51,640 from sales of publications and $16,178 from advertising, income on investments, exhibit, and miscellaneous sources. The operating (budgeted) disbursements were $151,686, which includes payment of all expenses of current publications, although the reserve of $12,000 set up outside of the current budget from 1937 and 1938 income towards the 1939 Book of Standards has been carried over for expenditure in 1940 inasmuch as the publication of the Book of Standards was not completed until February of this year. It will be seen that disbursements exceeded receipts by $1519.

An interesting and revealing way of presenting the story of 1939 finances is to show the source of the 1939 income dollar and how the 1939 expense dollar was spent, as set forth in the accompanying charts. It will be seen that slightly over half of the income dollar came from dues and entrance fees, about one-third of it from sales of publications, and that advertising, income from investments, exhibit, and miscellaneous sources including reserve, accounted for the remainder. On the expense side, 39 cents of each dollar expended went towards the



development and publication of standards and committee reports dealing with standardization; 19.7 cents went towards research activities, publication of papers and discussion in the *Proceedings* and BULLETIN; 8.3 cents to promotion of Society activities including membership and sales development work; and finally, 32.9 cents towards administrative expenses which include meetings and exhibit, membership, financial and sales work, Year Book and other routine publications, and general executive matters.

These charts clearly illustrate a fact already well known to those who are familiar with the financial operations of the Society, namely, that the Society's services to its members cost considerably more than the income from dues and that these services are possible only through the substantial income from sales of publications which constitute an important source of industry's support to the Society's activities.

1940 BUDGET

The budget for 1940 is based upon estimated current receipts of $169,500 of which $84,250 is from dues and entrance fees, $72,500 from sales of publications (which includes an estimate of $30,000 for sales in 1940 of the new Book of Standards), and $12,750 from advertising, income on investments, and miscellaneous sources. Operating disbursements have been budgeted at about $160,000 which provides for all customary Society activities including the regular and a number of special publications, and also a reserve of $6000 toward the next triennial Book of Standards. It will be seen that this budget anticipates a surplus of about $9500, some of which it is anticipated will be needed to balance budgets of the next two years—in other words, the scheme of triennial publication of the Book of Standards makes it necessary for the Executive Committee to consider the finances of the Society over three-year periods.

New Sustaining Members Listed

Eleven Additional Ones Bring Total to Fifty-four

THE ADDITION of eleven new Sustaining Members to the growing list of organizations which have already subscribed to this class of membership brings the total to 54. The nine latest Sustaining Members are listed below.

As mentioned in the January BULLETIN which listed fourteen new Sustaining Members effective as of January 1, it was pointed out that Sustaining Membership enables industrial companies, which benefit more than individuals from the utilization of materials standards, etc., to give an added measure of financial support to the work of the Society which has expanded a great deal in recent years resulting primarily from efforts to meet the needs of industry for recognized specifications and standard tests.

The annual dues for this class of membership are $100. In consideration each Sustaining Member receives *all* publications issued by the Society, which include in addition to those received on a regular membership, copies of all compilations of standards, various symposiums, and reprints of reports and papers that are issued from time to time. Moreover an extra set of the Society's most valuable publication, the triennial Book of Standards in three Parts with all supplements in the intervening years, is supplied to each Sustaining Member.

Other members of the Society are invited to give consideration to this class of membership.

New Sustaining Members

NATIONAL TUBE CO., E. C. WRIGHT, CHIEF METALLURGIST, PITTSBURGH, PA.

Affiliated with the Society as a company member since 1900, the National Tube Co. has for most of this period been represented in the Society by Dr. F. N. Speller, former Director of the Department of Metallurgy and Research. Doctor Speller is now retiring and other engineers and technical men who have formerly been active will continue their committee activities. Both Mr. Wright and H. R. Redington especially, have been active on Committee A-1 on Steel and the company has been represented on other technical groups including Committees A-5 on Corrosion of Iron and Steel, A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, D-1 on Paint, Varnish, Lacquer, and Related Products, and D-19 on Water for Industrial Uses.

THE PURE OIL CO., J. P. LANGFITT, ASSISTANT TO VICE-PRESIDENT, IN CHARGE OF REFINING, CHICAGO, ILL.

This company is following the activities of various committees of the Society through representation by engineers and technologists affiliated

with the company. They have been members of Committee D-2 on Petroleum Products and Lubricants for a number of years, serving on several subcommittees and more recently have become active in Committee B-5 on Copper and Copper Alloys, Cast and Wrought.

Reichhold Chemicals, Inc., Carl B. Fritsche, Manager, Plastics Division, Detroit, Mich.

The first affiliation of this company with the Society has been its recent acquisition of Sustaining Membership. Mr. Fritsche, whose office is at 601 Woodward Heights Boulevard, Detroit, has indicated that his company is concerned with the work of Committees D-20 on Plastics and D-1 on Paint, Varnish, Lacquer, and Related Products, and has applied for membership on these groups. This company is a leading producer in these fields.

United States Rubber Co., H. M. Frecker, Jr., Assistant Manager, Mechanical Goods Development, Passaic, N. J.

Connected with the Society as a company member for many years, this organization has been very active through its technical representatives particularly on Committees D-11 on Rubber Products and D-13 on Textile Materials. Mr. Frecker, a member of several D-11 subcommittees, is chairman of one of its most active groups, Subcommittee X on Physical Testing of Rubber Products. Other engineers in the company have aided in the advancement of the Society's work, including H. H. Weber, B. H. Foster, A. E. Jury, W. A. Gibbons, and Martin Castricum who has done much to stimulate interest in the Society's work in the Detroit area as a member of the Detroit District Committee.

Standard Oil Co. (Indiana), T. H. Rogers, Assistant Director of Research, Whiting, Indiana

Doctor Rogers has been very active in the work of A.S.T.M. groups, in particular, Committee D-2 on Petroleum Products and Lubricants. He has also been active in the work of Committee D-4 on Road and Paving Materials and Committee D-8 on Bituminous Waterproofing and Roofing Materials. Affiliated with Committee D-9 on Electrical Insulating Materials, he also serves the Society as a member of the Chicago District Committee. In his capacity as a member of many subcommittees of the committee on petroleum products he has taken a leading part in the development of standardization and research work.

Sears Roebuck and Co., Technical Laboratories, Department 817, Chicago, Ill.

This company has been a member of the Society since 1922, represented since 1924 by Miss Elizabeth Weirick, who also represented the company on Committee D-13 on Textile Materials, having cooperated in the work of several subcommittees including those on bleaching, dyeing, and finishing, and on household and garment fabrics. Many other phases of A.S.T.M. work are also of interest, the company being represented on Committees D-8 on Bituminous Waterproofing and Roofing Materials by H. Cooke, and D-12 on Soaps and Other Detergents, by J. H. Gregory.

The Commonwealth and Southern Corp., James H. Foote, Supervising Engineer, Jackson, Mich.

As a member of the Society since 1932, this corporation has been concerned especially with the work of Committee B-1 on Copper and Copper-Alloy Wires for Electrical Conductors and Committee A-5 on Corrosion of Iron and Steel, on both of which the company is represented by Mr. Foote. He served as secretary of Committee B-1 from 1934 to 1938, and on the death of J. A. Capp, became chairman. In this capacity he represents the committee on Committee E-5 on Standing Committees.

The Clark Thread Co., H. Grandage, Vice-President, Newark, N. J.

Since 1930 this company has been affiliated with the Society as a company member, with Mr. Grandage representing his company. Their interests lie principally, of course, in the work of Committee D-13 on Textile Materials, and Mr. Grandage has been a member of the committee for some ten years, serving on sections of Subcommittee A-1 on Cotton and Its Products.

American Viscose Corp., Frederic Bonnet, Director of Complaint-Service Dept., Marcus Hook, Pa.

This company, one of the largest producers of rayon and related materials, has been a company member of the Society since 1925, having been represented since 1935 by Mr. Bonnet. With their predominant interests in the textile field, Mr. Bonnet serves on Committee D-13, being affiliated with the sections of Subcommittee A-2 dealing with rayon, rayon fabrics, rayon staple and spun rayon yarn.

The Cleveland Electric Illuminating Co., A. A. Casey, Executive Engineering Staff, Cleveland, Ohio

This company has been a member since 1924, having in recent years been represented by C. R. Nichols, Engineer. In acquiring Sustaining Membership, Mr. Casey has been named as representative.

The Philadelphia Electric Co., Howard S. Phelps, Engineer, Special Investigation and Testing Division, Philadelphia, Pa.

This company, a member since 1922, has actively supported the Society's work through participation of its representatives on a number of Society committees and the personal interest in such work on the part of Nevin E. Funk, Vice-President, in Charge of Engineering. Mr. Phelps, Mr. Harold Farmer, and other engineers are active in Society work, the company's interests covering several technical committees. Mr. Farmer has served the Society in other capacities, notably as secretary of the Philadelphia District Committee.

New York District Meeting—April 4

What promise to be two very interesting discussions—one on "Engineers of Tomorrow" and the other "Testing for the Consumer"—are scheduled for the meeting being sponsored by the New York District Committee on Thursday evening, April 4, at the Hotel Pennsylvania. The meeting session will be preceded by an informal dinner—all members and others interested are requested to get reservation notices to the Committee Secretary, G. O. Hiers, National Lead Co., 105 York St., Brooklyn, N. Y., by April 1 if at all possible. The dinner is scheduled for 6:30 o'clock, preceded by cocktails.

Dr. A. L. Colston, Principal, Brooklyn Technical High School, in a lantern-slide illustrated address will cover unusual methods and facilities in use for directing youthful minds along scientific channels, his general subject being as indicated "Engineers of Tomorrow."

Mr. Ephraim Freedman, Director, Macy Bureau of Standards, R. H. Macy and Co., Inc., member of the Society for many years and active in the work of Committee D-13 on Textile Materials, in discussing "Testing for the Consumer" will cover various tests and methods used to determine qualities and properties which the consumer looks for in the things he buys. Color films will be used in connection with this talk.

Following these papers there will be a general discussion period.

Myron Parke Davis, Chief Chemist and Metallurgist, Otis Elevator Co., is chairman of the New York District Committee, with E. A. Snyder, Socony-Vacuum Oil Co., Inc., New York City, vice-chairman.

Chicago District Meeting on Plastics

A PROGRAM on plastics will feature the meeting being sponsored at the Palmer House on Wednesday, March 27, at 7:15 p.m., under the auspices of the Chicago District Committee. W. A. Zinzow, Chief Physicist, Bakelite Corp., an active A.S.T.M. member, and S. P. Miller, Plastic Dept., E. I. du Pont de Nemours and Co., Inc., are the speakers. Their talks will cover new plastics, applications, and test methods.

The authors plan to discuss latest developments in both the thermoplastic materials and also the thermosetting of plastics. Mr. Zinzow, who is active in the work of Committees D-20 on Plastics and D-9 on Electrical Insulating Materials, will also discuss the testing of plastics, first, the general philosophy of testing, and secondly, the A.S.T.M. methods, mentioning the types of apparatus required, reproducibility of results, etc.

The meeting will be open for discussion following the talks. Motion pictures covering phases of the plastics industry will be shown during the evening. A display of molded materials is also being developed.

This meeting is being arranged by the officers of the District Committee, D. L. Colwell, Paragon Die Casting Co., *Chairman*, and C. E. Ambelang, Public Service Co. of Northern Illinois, *Secretary*, with J. F. Calef, Automatic Electric Co., *Chairman of the Program Committee* and C. D. Prendergast, Western Electric Co., cooperating.

Symposium on Shear Testing of Soils

BECAUSE OF the widespread interest in testing of soils and the growing significance of soils technology, it has been decided to reprint in the form of a special publication the eight technical papers presented at the 1939 annual meeting comprising the Symposium on Shear Testing of Soils.

The symposium was developed by the Subcommittee on Methods of Testing for Shearing Resistance of Soils of Committee D-18 on Soils for Engineering Purposes. Arrangements were under the immediate direction of Prof. F. J. Converse, California Institute of Technology, assisted by G. P. Tschebotareff, Princeton University.

Each member of the Society and also committee members have received an announcement of this publication. Copies of this reprint from the 1939 *Proceedings* (now nearing completion) comprising 128 pages are available in heavy paper binding at 75 cents to members, the list price being $1.25.

The Book of Standards

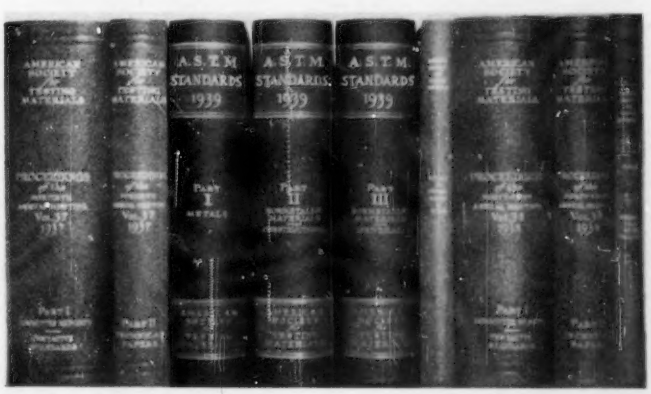
WITH THE distribution completed of Part I on Metals, the 1939 Book of A.S.T.M. Standards finally has been issued. While it was an inconvenience not to have had the complete book available sooner, every effort was made to rush the editing of standards, new typesetting, etc., and a great deal of satisfaction can be taken in that the books represent a considerable advance over any previous edition.

The standards, as published, represent a re-editing and review both on the part of the Headquarters staff and of the various subcommittees and standing committee responsible, which re-editing was rather time-consuming and contributed to the delay. Now that the books are issued, a determined effort will be made to keep all of the specifications and tests in satisfactory form, particularly from the editorial standpoint.

Of the 885 standards and tentative standards, all except 38 have been reset and of these 17 are methods of chemical analysis of metals which do not appear in any of the three parts of the Book of Standards, but are published in the volume on Methods of Chemical Analysis of Metals. Of the three parts of the book totaling about 3590 pages, 3455 are in the double-column format.

While many laudatory comments are being received on the general appearance of the book and other features, it is to be expected that a number of members may have some constructive comments which might make the Book of Standards of still more service, and members who do have suggestions along these lines will be rendering a service if they will forward them to A.S.T.M. Headquarters. The various decisions which have been made have been considered in the broad interests of all members of the Society and users of the publications.

Supplements to each part of the Book of Standards will be published late this year, incorporating all new and revised standards, all new tentative standards, and also revised tentative standards and proposed revisions. Each Part will be bound separately, in cloth.



Schedule of Meetings

DATE	COMMITTEE	PLACE
March 22...	C-12 on Mortars for Unit Masonry.....	Washington, D. C.
March 25...	A-6 on Magnetic Properties	Philadelphia, Pa.
March 27, 28	C-5 on Fire Tests of Materials and Construction...	New York City
April 5.....	D-8 on Bituminous Waterproofing and Roofing Materials.....	New York City
April 8, 9..	Executive Comittee.....	Philadelphia, Pa.
April 11, 12.	D-1 on Paint, Varnish, Lacquer, and Related Products	Cincinnati, Ohio
March 27...	CHICAGO DISTRICT MEETING	Chicago, Ill.
April 4.....	NEW YORK DISTRICT MEETING.....	New York City
June 24–28..	1940 ANNUAL MEETING....	Atlantic City, N. J.

Committee Week;

Actions on Standards

(*Continued from page 12*)

which have been under way for many years. The report will be in three parts: (1) description of purpose of tests, specimens exposed, and procedure followed; (2) results of inspections; (3) conclusions that the committee is able to draw.

The riveted plates at these same exposure sites have not been inspected this year and continue in the test.

The black sheets exposed in the atmosphere at Annapolis for over 20 years were inspected in April and October, 1939. Ten additional failures have occurred and others are now beginning to occur in the copper-bearing sheets. The latest failures will be recorded as usual, in the annual report.

Subcommittee VIII on Field Tests of Metallic Coatings has continued its inspections at the eleven test sites. It is paying particular attention to the unusual failures occurring from the underside of sheets exposed at Key West. Additional specimens were exposed at Sandy Hook in April and October to check an apparent difference in rate of corrosion during the six months ending at each time. Because of numerous requests that have been received, this committee will study the feasibility of initiating an exposure test program to study the effects on coating weathering of larger amounts of aluminum in the galvanizing bath than the 0.01 per cent now allowed by the Specifications for Zinc Coatings on Structural Steel Shapes, Plates and Bars, and Their Products (A 123 – 33).

To enable a more effective study to be made of the failures (perforation) of galvanized sheets now exposed, Subcommittee VIII will look into the possibility of making analyses of the coatings of duplicate specimens of the sheet specimens which have been stored since the exposure tests were started. For these analyses the same methods will be used as were used in the referee tests to characterize the specimens exposed in the wire tests.

Permission has been granted the Research Committee of the American Electroplaters Society to use and extend some of the committee's exposure test racks at Sandy Hook in connection with a new program of this group.

As it had promised, Subcommittee VII on Test Methods has studied the feasibility of combining the Test Methods for Uniformity of Coatings on Wire (A 191) and on Shapes (A 208) and enlarging the scope to include the Preece test for bolts, nuts, and screws. It is expected that the combined specifications will be ready for publication in June.

A number of the members of Subcommittee VI on Specifications for Metallic-Coated Products held an informal discussion on the future development of the Specifications for Zinc Coating (Hot-Dip) on Hardware and Fastenings (A 153 – 33 T) and it is hoped that active work will be started before June. It is proposed to add a heavier weight of coating class in Specifications for Electroplated Coatings, A 164 – 39 T (Zinc) and A 166 – 39 T (Chromium) and an intermediate weight of coating class in Specifications A 165 – 39 T (Cadmium) as suggested by the A.E.S.-A.S.T.M. Joint Committee. Under consideration also is the deletion of the terms "for mild service," "for general service," and "for severe service," used in these three specifications to describe the weight of coating classes and use only a class designation. This is to avoid possible confusion with the service expected from heavier weights of coatings called for in other specifications under the jurisdiction of Committee A-5.

Malleable Iron Castings

Pearlitic malleable iron and welding of malleable iron castings were the principal subjects which came up for discussion at the meeting of Committee A-7.

Subcommittee VI on Pearlitic and Alloy Malleable Iron reported that Doctor Lorig of Battelle Memorial Institute is collecting data on pearlitic malleable irons, and that these will be presented in the form of a paper at the annual meeting. There should be particular interest in this paper as there is need for more information on the pearlitic malleables, and their use is expanding rapidly. It is thought that when sufficient information is available the tentative specifications for pearlitic malleable-iron castings (A 220 – 39 T) which were issued by the A.S.T.M. last year, may be revised so as to give more specific limitations.

The subcommittee in charge of the committee's work on welding malleable castings, reported that information is being collected from all available sources on welding of malleable iron, and that it plans to prepare test bars which will be welded by different processes. It is expected that preliminary information resulting from this work will be available at the annual meeting of the Society in Atlantic City, June 24 to 28.

Iron-Chromium-Nickel and Related Alloys

A major activity of Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys, has been the compiling of authoritative data on mechanical, physical, and chemical properties of a large number of alloys falling under the jurisdiction of the committee. It was reported that the compilation was nearing completion and would probably be published during the coming year. The former compilation of data sponsored by Committee A-10 entitled "Tables on Chemical Compositions, Physical and Mechanical Properties and Corrosion Resistant Properties of Corrosion-Resistant and Heat-Resistant Alloys" was widely distributed because of the convenience and usefulness of the information provided.

One of the problems of the committee involves the development of a method of corrosion testing. Survey of the available information is under way on boiling liquid test so that a satisfactory standardized procedure can be recommended. It is possible that the committee may arrange to hold a round-table discussion on some phases of the corrosion testing of iron-chromium-nickel alloys.

In its 1939 report the committee included an extensive report on the metallographic examination of two heats of austenitic 18 per cent chromium, 8 per cent nickel steels which cooperating laboratories studied to determine the nature of the material that is precipitated at the grain

boundaries when an austenitic steel is given a heat treatment that renders it susceptible to intergranular corrosion. During the coming year the committee will continue its studies and attempt to correlate data concerning the corrosion behavior of the alloys investigated.

In the field of specifications for castings, the subcommittee in charge is planning to expand its personnel to include other interests concerned with the chromium and nickel-chromium alloy castings under its jurisdiction. This committee plans to develop any desirable or suggested revisions in the present specifications by means of a questionnaire circulated during the coming year. (In 1939 nine casting specifications covering various compositions were consolidated into four specifications carrying the designations A 198, A 221, A 222, and A 223.)

Corrosion of Non-Ferrous Metals and Alloys

Committee B-3 considered three subjects of current interest: (1) new series of tests involving total immersion, (2) the preparation of a standardized procedure for carrying out alternate immersion corrosion tests, and (3) the developing of atmospheric corrosion tests on stainless steel in contact with other metals—an extension of the galvanic and electrolytic corrosion studies previously conducted by the committees.

The total immersion tests to be carried out in five cooperating laboratories involve the use of three solutions; namely, normal sodium chloride brine, normal sulfuric acid, and normal sodium hydroxide and the following metals: commercial copper (phosphorized), commercial aluminum, commercial nickel, chemical lead, commercial zinc (Prime Western), commercial zinc (high grade), commercial tin, red brass (85 Cu, 15 Zn), and brass (70 Cu, 30 Zn). Tests are to be made in aerated and nonaerated solutions at 35 C. One of the important purposes of the tests is to determine the reproducibility of results from the standardized procedures which will be used.

Various interests are using alternate immersion tests to determine the corrosion resistant properties of various types of non-ferrous metals and alloys and need for a standardized procedure has been brought forcibly to the attention of the committee.

Very valuable results came from the committee's extensive long-time tests of couple combinations of widely used non-ferrous metals and alloys with test locations scattered throughout the country. The final results of these galvanic and electrolytic tests were issued by the committee last year and appear in the 1939 A.S.T.M. *Proceedings*. At the approaching Annual Meeting of the Society in Atlantic City, two technical papers will be sponsored by the committee, one on "The Influence of Cathode Area and Circuit Resistance in Galvanic Corrosion," by W. A. Wesley and "Some Observations of the Potentials of Metals and Alloys in Sea Water," by F. L. LaQue and G. L. Cox, each of these three men being associated with the International Nickel Co.

Copper and Copper Alloys, Cast and Wrought

Washington Meeting of Committee B-5

Some 45 committee members, visitors, and representatives of Government departments attended the two-day series of meetings of Committee B-5 on Copper and Copper Alloys, Cast and Wrought, in Washington, D. C., on February 29 and March 1. Including a meeting of the Advisory Committee and the main group there were 13 sessions. The committee met in Washington in order that representatives of the Federal Specifications Board, the Army, the Navy, the Bureau of Aeronautics and other departments, might conveniently participate in the discussions.

New proposed specifications covering cartridge brass and gilding metal had been developed by the Frankford Arsenal and after a discussion the committee felt these were in such satisfactory form as to justify reference to letter ballot for approval.

Two tentative specifications covering copper-alloy bearing and expansion plates for structural uses (B 100) and phosphor bronze sheet and strip (B 103) are to be proposed for adoption as standard. Specifications for naval brass rods (B 21) will be revised to include two new types of naval brass containing lead.

New specifications providing standardized requirements for brass wire in eight compositions ranging from 95 per cent copper, 5 per cent zinc, to 62 per cent copper, 38 per cent zinc have been prepared. Another new specification has been prepared for copper rods and bars similar to the provisions of Navy specification 47C2f.

Progress was reported in the revision of specifications for copper-alloy seamless condenser tubes and ferrule stock (B 111), discussions hinging largely on grain size and on the addition of certain elements intended to prevent dezincification. It was voted to approve the new tolerance table of the Copper and Brass Mill Products Assn. and to insert 73 per cent as the upper limit for the copper content of admiralty tubes.

The subcommittee on copper-base alloys for sand castings submitted a number of recommendations, one providing a change in the lead content of steam or valve bronze castings (B 61) to one per cent minimum. Proposed new specifications have been developed for high-strength yellow brass castings and a number of proposed revisions will be referred to a letter ballot in specifications for bronze castings for turntables, movable bridges and for plates of fixed bridges (B 22), for copper-base alloys in ingot form for sand castings (B 30) and in the classification of cast copper-base alloys (B 119).

Cooperation with Government Departments.—At all of the subcommittee meetings and the main committee meeting there were present representatives of one or more of the Government departments. There was a great deal of very friendly discussion in comparing the provisions of Government specifications with those of corresponding A.S.T.M. specifications and in many cases it was possible to reach a tentative agreement in standardizing upon such items as composition of materials and tolerances for gage, weight, and thickness. It will require some time for the distribution of information to the various departments of the Government and for changes to be made in existing specifications. However, the problems of each of these specification-making bodies were made especially clear in this meeting in Washington and the way has been paved for joint action in the future, particularly in the preparation of new specifications.

On the part of the A.S.T.M. subcommittees, every

effort will be made to keep the proper Government officials fully informed of proposed actions and of reasons for any proposed changes in existing specifications. This is quite necessary in order to bring about full cooperation from the proper officials in Government bureaus. It was emphasized that the Government was anxious to secure the benefit of the experience of well-qualified men in industry and the results of deliberations such as those in the committee meetings in Washington.

Die-Cast Metals and Alloys

It was announced at the meeting of Committee B-6 on Die-Cast Metals and Alloys that the harmonizing of A.S.T.M. and Government specification requirements for aluminum die castings had been achieved through the cooperation of the Government in making changes in its composition limits to bring them substantially in line with A.S.T.M. Specifications for Aluminum-Base Alloy Die Castings (B 85 – 39 T). The fact-finding committee on an 8 per cent magnesium alloy reported progress in arranging for the casting of standard test pieces with chemical limits agreed upon and other factors controlled in accordance with the subgroup's wishes. An informal report on tests of the aluminum die castings of high purity removed from exposure racks after five years, detailed data on which are expected to be included in the annual report, indicated no significant difference from the control tests of alloys of commercial purity.

The committee approved a recommended change in the zinc-base alloy No. XXV in the Specifications for Zinc-Base Alloy Die Castings (B 86 – 38 T) providing the allowable magnesium content to be 0.03 per cent instead of 0.02, and the allowable tin to be 0.005 per cent instead of 0.002. This was based on results of tests conducted by the New Jersey Zinc Co. Research Laboratory.

In its work on exposure and corrosion tests the data on the ten-year tests have been circulated to the subcommittee in charge and are recommended by Committee B-6 to be published by the Society with suitable comments on the commercial status of these alloys at the present time and the fact that new tests are under way on present-day commercial zinc alloys.

Light Metals and Alloys, Cast and Wrought

Committee B-7 and six of its subcommittees held well-attended meetings. One of the important actions taken was the approval, subject to committee letter ballot, of two new test methods for anodic coatings on aluminum, one covering a procedure for determining the scaling of the coating and the other for determining the weight of the oxide coating. These will be recommended to the Society for publication.

A group of four papers has also been arranged for the annual meeting of the Society, June 24 to 28, covering the following subjects:

Anodic Coatings as Seen Through the Microscope, by Fred Keller, Aluminum Research Laboratories,

Thickness of Anodic Coatings on Aluminum, by J. D. Edwards, Aluminum Research Laboratories,

Abrasion Resistance of Anodic Coatings on Aluminum, by H. G. Arlt, Bell Telephone Laboratories, Inc., and

Electrical Breakdown of Anodic Coatings on Aluminum, by K. G. Compton, Bell Telephone Laboratories, Inc.

Another important action was the proposed addition to the tentative specifications for magnesium-base alloy bars, rods, and shapes (B 107) of three new wrought alloys with controlled or high-purity base metals which offer considerably greater corrosion stability than the present alloys. The committee also decided to delete from the tentative specifications for magnesium-base alloy ingot for remelting all of the requirements for the wrought alloys since these are not marketed in ingot form.

Consideration will be given to the feasibility of consolidating the several existing specifications for aluminum alloy sheet and plate. A subgroup has been appointed to investigate the effect of impurities on aluminum alloys. Test methods for determining reflectivity, scratch resistance, and abrasion resistance are being developed.

The subcommittee responsible for the magnesium-base alloys is planning to give consideration to protective coatings for magnesium alloys castings, forgings, sheets, and other wrought products.

There has been considerable discussion in the committee concerning a scheme for briefly designating and classifying the light metals and alloys. A special committee will be appointed to study the classification and designation of aluminum alloys, following which there may be a similar study of the magnesium-base alloys.

Metallography

While Committee E-4 on Metallography took no action on matters relating to standards or recommended practices under development and the meeting consequently was concerned principally with routine business and considerations of further activities, the chairman did report that Committee A-1 on Steel had in mind referring to the new Tentative Method of Preparation of Metallographic Specimens (E 3 – 39 T) in connection with the macro-etching test in certain of the specifications for steels for use in high-temperature service, but before making definite reference wished to have the opinion of Committee E-4 on the macro-etching methods, since they were incorporated in E 3 for the first time this year.

It was pointed out that the present grain size standard for steel (E 19) covers only the austenitic grain size and that a standard for ferritic grain size was needed. The committee referred the matter to Subcommittee VIII on Grain Size for action. Problems in measuring the non-metallic inclusions in steel were discussed and the need for a standard method of measuring and reporting these inclusions was expressed. The establishment of a new subcommittee to study the subject was authorized.

There was an extended discussion of the preparation of metallographic specimens by electrolytic polishing and lapping methods and it was decided to promote a round-table discussion of these methods during the 1940 Annual Meeting. It is proposed that a number of experimenters and workers in this field be invited to present, informally, their experiences, in the hope that mutual consideration may prove helpful in advancing the use of the methods.

If possible, a summary of the discussions will later be prepared for the ASTM BULLETIN.

Refractories

One of the recommendations of Committee C-8 on Refractories involves the specifications for ground fire clay (C 105) which are to be revised to provide that 95 instead of 90 per cent of the commercial grade shall pass through a 20-mesh sieve. Requirements for superduty ground fire clay will also be added. Changes in the specifications covering lime for silica brick manufacture (C 49 – 24) were proposed for submission to Committee C-7 on Lime, the committee in charge of the specifications.

The Specifications for Fireclay Brick for Stationary Boiler Service (C 64 – 39) are to be withdrawn and replaced by two new standards, one covering materials for severe duty service, the other for moderate duty service. Also the committee plans to recommend the withdrawal of Specifications for Refractories for Construction of Incinerators (C 106 – 39) and for Fireclay Brick for Malleable Furnaces with Removable Bungs and for Annealing Ovens (C 63 – 39), and replace them with new specifications which will include a hot-load test as a means of determining refractoriness. This hot-load test is also to be included in the new specifications covering fireclay brick for severe duty and moderate duty boiler service.

During the past year the committee has been developing classifications of refractories and new proposals will cover low-heat duty, intermediate heat duty and high-heat duty fire clay and also classification requirements for insulating fire brick.

New definitions of abrasion, corrosion, erosion, and slagging will be published in the committee's report to be presented in June at the annual meeting. The Method of Test for True Specific Gravity of Burned Refractory Materials (C 135 – 38 T) is being recommended for adoption as standard.

The Standard Methods of Chemical Analysis of Refractory Materials (C 18 – 39) cover analytical procedures for a number of refractories including chrome ores and chrome brick. The latter are to be revised and brought up to date.

Another development by the committee are new tentative methods for determining the warpage of fire brick and tile. It was also announced that work was being started on an Industrial Survey of Refractories in the Zinc Industry. This will be the ninth in the series that the committee has issued.

The committee also considered the publication of its Manual on Refractory Materials, which will include in addition to all of the A.S.T.M. specifications and tests on refractories the industrial surveys, and plans to recommend to the Society that this be issued in the fall after the autumn meeting of Committee C-8.

Thermal Insulating Materials

Since its organization in 1938 Committee C-16 on Thermal Insulating Materials has been actively working on a program for the formulation of test methods and specifications relating to industrial thermal insulating materials (except those used in the building and insulating refractory fields). At its meeting the committee considered methods for determining the physical properties of preformed insulation and also tests for thermal properties, except thermal conductivity, of all forms of insulation. The subcommittee responsible for flexible, blanket, loose-fill, and miscellaneous insulation held a well-attended meeting at which its program of work was furthered.

Considerable progress has been made in the preparation of standard physical test methods for various types of insulating materials. The tests under development cover procedures for determining compressive strength, flexural strength, impact resistance, etc. It is expected that within the coming year these methods will be ready for final approval by the committee.

The subcommittee on thermal conductivity which functions as a joint committee of the American Society of Heating and Ventilating Engineers, American Society of Refrigerating Engineers, National Research Council, and A.S.T.M., also held a meeting at which its program of work was considered. This joint committee is studying three different types of conductivity test, the guarded hot-plate method, the guarded hot-box method, and the guarded-end cylinder method for testing cylindrical pipe coverings. The test procedure by the guarded hot-plate method is practically completed.

Petroleum Products and Lubricants

Washington Meeting of Committee D-2

At the meetings of Committee D-2 on Petroleum Products and Lubricants held in Washington, D. C., March 11 and 12, it was announced that one of the members, Dr. T. H. Rogers, Associate Director, Whiting Research Laboratory, Standard Oil Co. of Indiana, was selected to be the guest of honor at the annual dinner. He is one of the several members of the Society who were recently honored by being selected as "Modern Pioneers on the Frontiers of Industry."

Subject to letter ballot the committee plans to refer to the Society for recommended approval a method for the determination of carbonizable substances in white mineral oil, and, also, to publish as information and for comment a method for the determination of aniline point.

Organization meetings of newly created subcommittees were held dealing with the determination of naphtha and chlorofom insolubles in used oils and the determination of sulfur, chlorine, and phosphorus in EP lubricants.

Minor changes will be made in the Stoddard Solvent specification (D 484 – 38 T) in anticipation of adoption as standard. Plans were formulated to publish tables which would facilitate the conversion of Kinematic viscosities to Saybolt viscosities and for the determination of viscosity index.

Road and Paving Materials

The decision to refer to letter ballot of the committee two proposed new tentative specifications for materials for stabilized base course and for stabilized surface course was an important action taken by Committee D-4. In addition there will be recommendations to the Society on a number of the other specifications in the charge of this group.

The proposed new specifications cover the quality and size of sand-clay mixtures; gravel, stone or slag screenings, or sand, crusher run coarse aggregate consisting of gravel, crushed stone or slag combined with soil mortar or any combination of these materials for use in the construction of a stabilized base course (or stabilized surface course). The requirements are intended to cover only materials having normal or average specific gravity, absorption and gradation characteristics. Where materials such as caliche, gypsum, limerock, and water soluble salts are to be used appropriate limits suitable to their use must be specified. Three types of base (or surface) stabilized mixtures are specified; namely, sand-clay mortar; coarse graded aggregate; and gravel, stone or slag screenings, or sand.

The existing tentative specification requirements for quick-setting emulsified asphalt (for penetration and surface treatment) (D 401 – 36 T) and for asphalt plank (D 517 – 38 T) are to be referred to letter ballot for adoption as A.S.T.M. standards.

The growing use of the Los Angeles rattler in determining abrasion of aggregate led the committee to consider the possibility of eliminating the abrasion test using the Deval machine. In addition to changes in the specifications for crushed stone for waterbound base and surface courses (D 489 – 38 T) the committee is also developing revisions in several of its other specifications.

Coal and Coke

Committee D-5 on Coal and Coke agreed to recommend to the Society a number of changes in the present methods of sampling of coal. The tentative revisions of the Standard Method of Sampling Coal for Analysis (D 21 – 16) are to be advanced to standard status. These revisions provide for methods of reduction of gross samples of coal by mechanical means which are considerably more accurate than hand methods of reduction because of elimination of personal errors. The acceptance by the Society of this revision as standard will necessitate some changes in the Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (D 271 – 37); consequently the present tentative revisions of these methods are to be recommended for adoption.

The committee decided to propose a number of revisions of the present Tentative Method of Sampling Coals Classed According to Ash Content (D 492 – 38 T). It is believed that these revisions constitute a considerable improvement in obtaining a more representative sample for analysis. The method as revised is to be continued as a tentative standard.

Another action of the committee concerns the present Tentative Definitions of the Term Coke (D 121 – 36 T) which will be recommended for adoption as standard in a revised form.

Electrical Insulating Materials

Washington Meeting of Committee D-9

Several recommendations were approved for reference to letter ballot as a result of the meetings of Committee D-9 on Electrical Insulating Materials held in Washington on February 26 and 27, there being all told thirteen sessions.

Revisions in the following standard and tentative standard test methods are expected to be referred to the Society: electrical insulating oils (D 117), sheet and plate materials (D 229), laminated tubes (D 348), laminated round rods (D 349), and flexible varnished tubing (D 372); also, specifications for phenolic laminated sheet for radio applications (D 467).

Three existing tentative standards are to be recommended for adoption; namely, tests for conducting paths in slate (D 273), specifications for flexible varnished tubing (D 350), and methods of testing shellac (D 411).

Active work is under way on a large number of projects in the field of both standardization and research, which will eventually result in the development of proposed new standards and revisions in certain existing specifications and tests.

Rubber Products

At the 15 meetings of subcommittees and the main session of Committee D-11 on Rubber Products several actions were taken which will result in a number of important recommendations to the Society. Several new specifications and tests were approved for submission to letter ballot including procedures for testing hydraulic brake hose, as developed by Technical Committee A on Automotive Rubber. A new section is being organized to investigate the suitability of tests of hose used in automotive cooling systems (heater and radiator). The methods for examination of all types of rubber hose (D 380 – 39 T) will continue as tentative with a revision involving test conditions for hydraulic tests for high-pressure hose.

Changes are to be incorporated in the methods of testing flat rubber belting (D 378 – 39 T) involving shape of specimen for the tension test requirements, the measurement of thickness, and the direction of taking test specimens. A *kerosine-benzol* swelling test is to be added for use especially in connection with belting intended for conveying products which might require an oil-resistant belting.

Specifications covering three types of insulated wire and cable, D 27, D 353, and D 469 will be slightly revised taking into consideration metallic coatings other than tin on the wire. Certain changes will also be embodied in the size of minimum conductors. Of particular interest in this field are proposed new specifications covering ozone resisting type of wire insulation.

The subcommittee concerned with abrasion is developing standardized procedures involving tearing and cutting as methods of determining resistance to punching and related characteristics. It is probable that the existing Tentative Methods of Test for Abrasion Resistance of Rubber Compounds (D 394 – 37 T) will be suggested for adoption as standard.

In the work on aging, an accelerated light aging procedure using artificial light has been practically completed and will be submitted at the next meeting of Committee D-11. The present tests for accelerated aging of vulcanized rubber (D 428 – 36 T), classified as the air-oven and oxygen-pressure-chamber methods will be changed editorially, the two methods being separated and issued as separate standards. Also, a more highly accelerated test for aging has been developed, conducting the test at 80 C.

The existing Tests for Compression Set of Vulcanized

Rubber (D 395) are to be revised, the major change involving construction of the apparatus for set under constant load.

Technical Committee A on Automotive Rubber has developed proposed testing procedures for load deflection of rubber in compression which were approved by Committee D-11.

The subcommittee concerned with rubber products for absorbing vibration examined four hand-operated hardness testing machines as developed by different manufacturers, this being done at the request of Technical Committee A. In order to develop further data the machines will be circulated among the members for experimental use.

New methods of test for compression flexing (compression hysteresis and heat build up) will be available in time for inclusion in the annual report of the committee to be presented at the annual meeting. These will probably be recommended for publication as tentative. The methods will involve the use of flexometers developed by St. Joseph Lead Co., The Firestone Tire and Rubber Co., and The B. F. Goodrich Co.

The committee on tests of liquid rubber products, which is a rapidly developing field, discussed proposed methods of test for latex. Investigative studies are under way and will probably be reported to the main committee in June.

In the field of hard rubber an extended cooperative test program will be undertaken immediately to evaluate present methods of tests. Twelve cooperating laboratories will carry out carefully prescribed tests on three different hard rubber compounds. One of the purposes of this work is to develop any defects in the present methods and also to bring to light improvements in the procedures.

Technical Committee A on Automotive Rubber, which functions as a joint committee of the Society of Automotive Engineers and A.S.T.M. prepared specifications for first grade motor mounting compounds classified by physical properties. These have been referred for approval to the Standards Committee of the S.A.E. Also recommended to the S.A.E. standards group are proposed specifications for hydraulic brake hose.

Because there are a number of problems involving the use of rubber in the automotive field, which might be solved most effectively by joint cooperation of the industries concerned, consideration is being given to the possibility of establishing a foundation for scientific research. Involved problems or ones of real fundamental nature could be investigated through such a set-up.

Soaps and Other Detergents

New York Meeting of Committee D-12

A number of important actions resulted from the meetings of Committee D-12 on Soaps and Other Detergents and its subcommittees held on March 11 and 12 in New York City. The meetings were well attended with about 45 men present at the sessions. A luncheon on March 12, followed by a general meeting of the whole committee, concluded the program.

This group, one of the most active Society committees, plans to recommend a number of new specifications and as indicated below will refer several other interesting matters to the Society.

At the meeting W. D. Pohle, Naval Stores Research Division, U. S. Bureau of Chemistry and Soils, spoke of the research program on rosin and its uses, which is being followed at the Bureau, with the idea of finding new uses for rosin as well as increasing the amounts now being consumed in the usual fields.

New tentative specifications for pure and blended palm oil soaps, pure and blended olive oil soaps, sodium sesquisilicate, and sodium tetrapyrophosphate were approved for submission to the Society at the annual meeting in June.

The section on built soaps decided to recommend for publication in the annual report for information and criticism only, two proposed specifications covering grit soaps. The section on specifications for sulfated oils is very much encouraged by its progress on laundering tests to be used for evaluating sulfated and sulfonated detergents, and hopes to complete its work on this during the year. The section on metal cleaners also is reporting good results, and hopes to be able to make some definite recommendations soon. All other sections also reported satisfactory progress.

The list of definitions was revised and enlarged and definitions of further terms were requested.

It was announced that encouraging progress is being made on the proposed monograph which will describe various detergents, tests, and uses. There has also been prepared a paper on the subject of soaps and other detergents covering methods of manufacture and various uses. One of the basic purposes of this paper is to furnish members of the Society and others who are concerned with these materials information on the standardized specifications and methods of test and analysis so that the results of the work of Committee D-12 will be used more generally. This will probably be published in the BULLETIN, possibly in the May issue.

Textile Materials

Charlotte, N. C., Meeting of Committee D-13

The regular Spring Meeting of Committee D-13 on Textile Materials held in Charlotte, N. C., March 13 and 14, was quite well attended with upwards of 100 members and guests present. There were some 17 meetings, including a Technical Session at which the following papers were presented:

Synthetic Organic Chemicals in Textile Finishing—D. E. Truax, Stein, Hall and Co.

The Influence of Variety, Locality of Growth, and Season on the Fiber and Spinning Properties of Cotton—R. W. Webb, U. S. Department of Agriculture.

Standardization of Color Names, The ISCC-NBS Method—Dorothy Nickerson, U. S. Department of Agriculture.

Quality Criteria for Spun Rayon Fabrics—Alexis Sommaripa, E. I. du Pont de Nemours and Co., Inc.

Committee D-13 and the A.S.T.M. Standards on Textile Materials—H. J. Ball, Lowell Textile Institute.

At the informal dinner on March 13 with Dr. R. W. Webb acting as Toastmaster, the Mayor of the city, Ben E. Douglas, extended greetings; Secretary-Treasurer C. L. Warwick, discussed the work of the Society, and its committees, and Professor Ball, Chairman of Committee D-13, extended greetings to the visitors who had attended the meetings.

A large number of actions in the field of standardization were approved at the meeting for reference to letter ballot, including proposed new standards as follows: methods of test and tolerances for glass cloth; also for glass braid for electrical purposes; recommended practice for computing the number of tests to be specified in determining an average characteristic of a textile material; methods of testing for waterproofness and mothproofness of textiles; and specifications for blanketing.

To be referred to the Society for adoption as standard are the following: tentative specifications for terry (turkish) toweling (D 505), tentative revision of specifications for textile testing machines (D 76), and tentative methods of testing and tolerances for continuous filament rayon yarns (D 258).

There will be recommended revisions of existing standards and tentative standards covering the following: cotton yarns (D 180), hose duck and belt duck (D 181), tire cord, woven and on cones (D 179), cotton fibers (D 414), woven textile fabrics (D 39), fluidity of dispersions of cellulose fibers in cuprammonium hydroxide (D 539), bleached wide sheeting (D 503), and textile testing machines (D 76).

Soils for Engineering Purposes

Among the important actions taken by Committee D-18 on Soils for Engineering Purposes was the approval for reference to committee letter ballot of four proposed test methods, three of which apply to soil cement mixtures. These four methods, listed below, have been the subject of considerable study in the committee and particularly in the subgroups concerned with physical characteristics of soils and methods of testing for stabilized soils, Subcommittees IV and V, respectively.

Proposed Methods of Test for:

Moisture-Density Relations of Soil-Cement Mixtures.
Wetting and Drying of Compacted Soil-Cement Mixtures.
Freezing and Thawing of Compacted Soil-Cement Mixtures.
Determining the Water Absorption and Resistance to Plastic Flow of Mixtures of Soil and Emulsified Asphalt.

There has been considerable activity concerning the development of satisfactory definitions and symbols pertaining to soils. The committee anticipates that the work of its Subcommittee I on Nomenclature and Definitions headed by W. P. Kimball may result in recommendations to the Society during the coming year.

Methods of Testing

INTERPRETATION AND PRESENTATION OF DATA; DESIGNATING NUMERICAL REQUIREMENTS IN STANDARDS; TENSION TESTING; SPEED OF TESTING

Interpretation and Presentation of Data.—The A.S.T.M. Manual on Presentation of Data published several years ago and subsequently amplified and revised editorially has been very widely distributed. There is a steadily growing interest in the general subject of presentation and interpretation of data and the advantages of using so-called statistical methods of analysis. Work in this field is in the charge of Technical Committee IX of A.S.T.M. Committee E-1 on Methods of Testing. At its Detroit meeting, a number of additions and improvements in the Manual were discussed and the committee announced that it has in preparation control charts for coefficient of variation and a new supplement to be added to the Manual covering relation between the number of tests and sampling errors of averages.

The committee expects that this work will be completed so that a new printing of the Manual can be effected during 1940.

Designating Numerical Requirements in Standards.—Another section of Committee E-1 is concerned with the designation and interpretation of numerical requirements and there have been under consideration proposed recommended practices. The recommendations are intended to assist the various standing committees in the use of uniform terms and conventions in expressing the numerical requirements in specifications and methods of testing. Their aim is to outline practices which should aid in clarifying the intended meaning of limiting and tolerance values, with which test values are compared in acceptance and rejection of material. Certain non-numerical terms closely related to numerical expressions are also included.

The practices give interpretations to the following:

(1) The phrase "to the nearest . . . . .", when applied to a specified limit.
(2) The underlining of figures in a specified limit, for example, "1.500."
(3) The symbol "±," when applied to a specified value of maximum permissible deviation.
(4) The term "average."

It is planned that this proposed tentative recommended practice will be referred to the Society for approval.

Tension Testing.—Because of the widespread use and importance of the tension test in evaluating strength of certain materials, the Methods of Tension Testing of Metallic Materials (E 8 – 36) are very significant. These are in the charge of a Section on Tension Testing headed by R. L. Templin, Chief Engineer of Tests, Aluminum Company of America, and were discussed at the Detroit meeting of the committee. A number of changes which have been under development were approved and are expected to be incorporated in the existing methods. Among the changes are inclusion of more satisfactory requirements concerning test specimens and related matters pertaining to the testing of piping and tubular products. Another change involves the statement concerning the importance of speed of testing.

Effect of Speed of Testing.—In connection with the revision of the Methods of Tension Testing (E 8 – 36) the Section on Effect of Speed of Testing has made recommendations regarding the basic requirements for speed specifications. A statement from this standard follows:

"(a) The speed at which a specimen is strained may have a marked effect on the values found for the tensile properties. Therefore, in specifications requiring definite values for the tensile properties, permissible limits for the speed of testing should be specified. By speed of testing is meant the rate of separation of the two ends of a measured gage length of uniform cross-section. This is a true measure of rate of increase of strain when expressed as the change per unit of gage length and per unit of time. Convenient units are inches per inch per minute or per cent per minute. In the range in which stress is proportional to strain, the rate of application of stress is proportional to

the rate of strain. This permits the more convenient measure of rate of change of stress in pounds per square inch per minute which is proportional to the rate of strain in inches per inch per minute. It is recognized that rate of strain is not easily measured in commercial testing. If, however, speed of testing has an important influence upon tensile properties of a given material, it is the rate of strain which must be held within prescribed limits.

"(b) The permissible range of speed should be chosen so that the variation in tensile properties produced by this range of speed with exactly similar specimens from one lot of material will be of the same order as the probable variation between specimens from different lots of reputedly similar material.

"(c) The change in tensile strength values produced by a change in the rate of straining is usually considerably less than that observed for the yield strength. The range of permissible speeds is, therefore, wider."

This section has been sponsoring an investigation of the effects of speed on the results obtained in tension tests of metallic materials. In this investigation, which is being carried out at the University of Illinois under the direction of Prof. H. F. Moore, tests have been made on several materials, including steels, copper, brass, aluminum, magnesium, and monel metal. Special equipment has been used in order to eliminate variables attributable to the characteristics of the machines used, the testing technique, and the personal equation. This method of attack has produced results of considerable fundamental importance which have been confirmed by other tests in various commercial laboratories without the use of special equipment. The resulting data are expected to be reported to the Society in June.

Microfilm Sets of Periodicals

THE COMMITTEE on Scientific Aids to Learning, President Conant of Harvard, chairman, has made a grant to cover the cost of making a microfilm master negative, on the most expensive film, of sets of volumes of scientific and learned journals.

This permits the non-profit Bibliofilm Service, which is operated by the American Documentation Institute in the Library, U. S. Department of Agriculture, Army Medical Library, Geological Survey Library, and National Bureau of Standards Library to supply microfilm copies at the sole positive copy cost, namely, 1 cent per page for odd volumes, or a special rate of $^1/_2$ cent per page for any properly copyable 10 or more consecutive volumes.

The number of pages will be estimated on request to: Bibliofilm Service, care U. S. Department of Agriculture Library, Washington, D. C.

Ceramics—Clay Products and Whitewares

JUST RECEIVED from the Division of Mineral Industries Extension, School of Mineral Industries, Pennsylvania State College, is Volume III on Clay Products and Whitewares of the series of books on ceramics being printed by this body in connection with their extension courses. This book intended as a text for those in the final year of the course is one of a series of four. It covers in detail such subjects as clay forming, drying and driers, firing clay products, ceramic calculations, testing of clays and clay products, apparatus for testing clay products, whitewares, and glazes and colors.

The book makes extensive use of the data in publications issued by the A.S.T.M., The American Ceramic Society, and the American Refractories Institute. The section on "Testing of Clays and Clay Products" and "Apparatus for Testing" incorporate particularly a number of A.S.T.M. specifications and tests.

Further information concerning this publication, which was written by Edward P. McNamara, Supervisor of Ceramics Extension, may be obtained by writing the School of Mineral Industries.

Colorimetric Analysis of Metals

RECENTLY ISSUED by the Carl Zeiss Co. is a 105-page book covering "The Absolute Colorimetric Analysis of Metals by the Use of the Pulfrich Photometer" including directions for absolute colorimetric analyses of iron, steel, and light alloys. This book should be of interest to a number of members of the Society.

The foreword points out that one of the newest high-speed methods of analysis with a physico-chemical basis is absolute colorimetry. The book, printed in English throughout, is divided into two sections, Part I on the apparatus and its manipulation, 21 pages; Part II on procedures, giving details on ferrous and non-ferrous materials, 84 pages.

Determination of the elements in steel and in non-ferrous materials is clearly classified and the information is arranged systematically under each determination—for instance, the first item is literature, the second, chemical range, then, reaction, reagents and apparatus, required procedure, calculation, sources of error, accuracy, and finally, the length of time required.

Copies of this cloth-bound publication can be obtained from Carl Zeiss, Inc., 485 Fifth Ave., New York, N. Y., at $2 each.

Calendar of Society Meetings

(Arranged in Chronological Order)

AMERICAN CERAMIC SOCIETY—Forty-second Annual Meeting, April 7–12, Royal York Hotel, Toronto, Canada.

AMERICAN CHEMICAL SOCIETY—Spring Meeting, April 8–13, Cincinnati, Ohio.

AMERICAN SOCIETY OF CIVIL ENGINEERS—Spring Meeting, April 17–19, Kansas City, Mo.

AMERICAN WATER WORKS ASSOCIATION—Annual Meeting, April 21–25, Kansas City, Mo.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS—Spring Meeting, May 1–3, Worcester, Mass.; Semi-Annual Meeting—June 17–21, Milwaukee, Wis.

AMERICAN FOUNDRYMEN'S ASSOCIATION—Forty-fourth Annual Convention and Exhibition, May 6–10, Palmer House, Chicago, Ill.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS—Thirty-second Semi-Annual Meeting, May 13–15, Statler Hotel, Buffalo, N. Y.

SOCIETY OF AUTOMOTIVE ENGINEERS—Summer Meeting, June 9–14, The Greenbrier, White Sulphur Springs, W. Va.

American Society for Testing Materials—Forty-third Annual Meeting, June 24–28, Atlantic City, N. J.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Summer Convention, June 24–28, Swampscott, Mass.

NEW MEMBERS TO MARCH 13, 1940

The following 96 members were elected from January 12 to March 13, 1940, making the total membership 4259:

Company Members (20)

CAPITAL TRANSIT CO., J. P. Billheimer, Superintendent of Building Maintenance, Thirty-sixth and M Sts., N. W., Washington, D. C.

CONGOLEUM-NAIRN, INC., P. C. Wetterau, Works Chemist, Marcus Hook, Pa.

COOK PAINT AND VARNISH CO., J. S. Ayres, 3301 Bourke Ave., Detroit, Mich.

DOW-WELD CO., INC., L. B. Johnson, President, Twenty-first West of Oak St., Baltimore, Md.

ESTADO PETROLEUM CORP., E. E. Greiner, Superintendent, 1358 E. Twenty-third St., Long Beach, Calif.

MONARCH RUBBER CO., THE, J. R. Corrigan, Chemist, Hartville, Ohio.

MOTOR FUELS CORP., T. M. Lumly, Superintendent, Box 520, Levelland, Tex.

NASHUA MANUFACTURING CO., R. L. Whitman, Vice-President, 40 Worth St., New York, N. Y.

NEW YORK, CHICAGO, AND ST. LOUIS RAILROAD CO., THE, A. C. Harvey, Chief Engineer, Cleveland, Ohio.

*PURE OIL CO., THE, J. P. Langfitt, Assistant to Vice-President, In Charge of Refining, 35 E. Wacker Drive, Chicago, Ill.

*REICHHOLD CHEMICALS, INC., C. B. Fritsche, Manager, Plastics Division, 601 Woodward Heights Boulevard, Detroit, Mich.

SOUTHERN VITRIFIED PIPE ASSN., D. M. Strickland, Manager, 628 Sycamore St., Cincinnati, Ohio.

SPICER MANUFACTURING CORP., S. L. Widrig, Chief Metallurgist, 4100 Bennett Road, Toledo, Ohio.

STANDARD PRODUCTS CO., THE, W. J. Friderici, Chief Engineer, Port Clinton, Ohio.

STERN AND CO., INC., I., S. J. Blaut, Metallurgical Engineer, 218 W. Fortieth St., New York, N. Y.

TAYLOR INSTRUMENT COS., R. D. Thompson, Physical Chemist, 95 Ames St., Rochester, N. Y.

TAYLOR REFINING CO., J. L. Sewell, General Superintendent, Box 1268, Corpus Christi, Tex.

TOKHEIM OIL TANK AND PUMP CO., R. H. Bowman, Engineer, 1600 Wabash Ave., Fort Wayne, Ind.

TRINIDAD LEASEHOLDS, LTD., F. L. Melvill, General Manager, Pointe-à-Pierre, Trinidad, B. W. I.

UNITED STATES STEEL EXPORT CO., G. J. S. Thompson, Assistant Manager, Merchandising Service Division, 30 Church St., New York, N. Y.

Individual and Other Members (69)

ALABAMA STATE HIGHWAY DEPT., TESTING LABORATORY, G. P. Thigpen, Testing Engineer, Montgomery, Ala.

ANDERSON, M. F., Director of Development, Footwear, Mechanical and Sundries Manufacturing, Dominion Rubber Co., Ltd., 1665 Notre Dame St. E., Montreal, P. Q., Canada.

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BERRY, H. R., Asiatic Petroleum Corp., 50 W. Fiftieth St., New York, N. Y.

BETTENDORF, W. E., Vice-President and General Manager, The Bettendorf Co., Bettendorf, Iowa.

BOWLING, A. L., Cinder Block, Inc., of Roanoke, Cleveland Ave. and Eighteenth St., S. W., Roanoke, Va.

BUCHHOLTZ, A., Chief Chemist, Cia. Argentina de Cemento Portland, Sierras Bayas, Argentina.

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MACLEAN, E. A., Professor of Civil Engineering and Head of Department of Civil Engineering, Rose Polytechnic Inst., Terre Haute, Ind.

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OKLAHOMA STATE HIGHWAY COMMISSION, C. R. Reid, Engineer of Materials and Tests, State Capitol, Oklahoma City, Okla.

OKLAHOMA STATE HIGHWAY COMMISSION, H. X. White, Bridge Engineer, State Capitol, Oklahoma City, Okla.

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* See article on Sustaining Members, p. 39.

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UNIVERSITY OF WYOMING, CIVIL ENGINEERING DIVISION, H. T. Person, Chairman, Civil Engineering Division, Laramie, Wyo.

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WOLLNER, H. J., Consulting Chemist, Office of the Secretary, U. S. Treasury Dept., 3508 Bureau of Internal Revenue Building, Washington, D. C.

Junior Members (7)

KINDQUIST, E. B. T., Research Assistant, The International Nickel Co., Inc., Bayonne, N. J. For mail: 404 Riverside Drive, New York, N. Y.

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PERSONALS

* * * News items concerning the activities of our members will be welcomed for inclusion in this column.

K. A. LINDNER, formerly Manager, Baltimore Plant, American Smelting and Refining Co., Baltimore, Md., is now General Manager, American Smelting and Refining Co., Barber, N. J.

W. P. MUNGER is connected with the Reinforcing Bar Dept., Joseph T. Ryerson and Son, Inc., Buffalo, N. Y. He was Assistant Designing Engineer, American Nepheline Corp., Rochester, N. Y.

C. W. GEORGI, formerly Chief Chemist, Enterprise Oil Co., Inc., Buffalo, N. Y., is now Technical Director, Research laboratory, Quaker State Oil Refining Corp., Emlenton, Pa., with mailing address still in Buffalo, N. Y.

E. T. NETTLETON, who was Secretary and Engineering Director, New York State Crushed Stone Assn., Inc., Albany, N. Y., is now General Superintendent, L. Suzio Construction Co., Meriden, Conn., and York Hill Quarries Co.

E. K. BOLTON, Chemical Director of E. I. du Pont de Nemours & Co., Wilmington, Del., has been elected a Director of the American Chemical Society, succeeding R. E. WILSON, President, Pan American Petroleum and Transport Co.

J. L. HAMILTON, Chief Engineer, Century Electric Co., St. Louis, Mo., has been nominated for Vice-President of the South West District of the American Institute of Electrical Engineers.

JOSEPH WINLOCK, Chief Metallurgist, Edward G. Budd Manufacturing Co., Philadelphia, Pa., delivered the first "Sauveur Night" lecture at the Boston Chapter meeting of the American Society for Metals, held in January.

J. M. YOUNG, Consulting Engineer and Professor of Engineering, University of Hawaii, Honolulu, has been appointed one of five members of the newly formed territorial commission of labor and industrial relations in Hawaii.

L. N. SHANNON, Vice-President, Stockham Pipe and Fittings Co., Birmingham, Ala., has been nominated for president of the American Foundrymen's Assn., and H. J. ROAST, Vice-President, Canadian Bronze Co., Montreal, Canada, has been nominated as a director to serve for a term of three years.

F. T. LLEWELLYN, for many years associated with the American Bridge Co. and Carnegie Steel Co., has retired after almost 50 years of continuous service with the company. At a recent meeting in New York he was awarded a certificate as an honorary member of the American Welding Society in connection with his work and development of engineering data for use in the design of welded structures. The certificate was presented by Dr. C. A. ADAMS, Professor of Engineering, Emeritus, Harvard University and Consulting Engineer, Edward G. Budd Manufacturing Co., Philadelphia; first president of the American Welding Society and the only other living honorary member.

W. M. SCOTT, has been appointed Chief, Cotton Chemical Finishing Division, Southern Regional Research Laboratory, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, New Orleans, La.

NECROLOGY

We announce with regret the death of the following three members:

FRANCIS H. GILPIN, Assistant to Manager, Asphalt Sales Dept., The Texas Company, New York, N. Y. Member since 1928. For a number of years Mr. Gilpin was a member of Committee D-8 on Bituminous Waterproofing and Roofing Materials and Subcommittees VIII and IX.

EDWARD E. HUGHES, Honorary President, Rail Steel Bar Assn., 228 N. La Salle St., Chicago, Ill. Member since 1912. Mr. Hughes who was 77 years old was one of the organizers of the Rail Steel Bar Association in 1911. He served as President until his retirement from active business in 1931 when he was elected Honorary President. At the time of his death Mr. Hughes was one of the representatives of the Rail Steel Bar Association in its membership on Committee A-1 on Steel and Subcommittee V on Steel Reinforcement Bars. He was a member of former Committee C-2 on Reinforced Concrete and at one time represented the Society on the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete.

EMERY C. MARSHALL, General Superintendent of Refineries, Socony-Vacuum Oil Co., Inc., White Eagle Division, Kansas City, Mo. Member since 1938.

Catalogs and Literature Received

THE BRISTOL CO., Waterbury, Conn. Catalog 4050 entitled "Bristol's Air-Operated Free-Vane Controllers." This 32-page publication describes free-vane recording controllers, indicating controllers, throttling controllers, etc. Illustrated. Also, three two-page folders Bulletins 546, 542, and 540, describing the Rockwell-Bristol dilatometer, wide-strip tachometers, and P.V.T.T. recorders.

PITTSBURGH EQUITABLE METER CO., 400 Lexington Ave., Pittsburgh, Pa. Bulletin No. M-704, 14 pages, on "Industrial Metering." Describing liquid and gas meters, including a wide range of type and size.

THE PHILADELPHIA THERMOMETER CO., 915 Filbert St., Philadelphia, Pa. Catalog No. 104, 11 pages, entitled "The Philadelphia Merc-to-Merc Temperature Controls"—thermostats, relays, thermometers, and hydrometers for all industrial, technical, and laboratory, purposes. Briefly describes mercury in glass thermostats and mercury plunger relays.

CLAY-ADAMS CO., INC., 44 E. Twenty-third St., New York, N. Y. Catalog No. 110, 15 pages, describes centrifuges for physicians, hospitals, bacteriological, clinical, and chemical laboratories, with a new arrangement for micro and semi-micro work.

WEKSLER THERMOMETER CORP., 535 Pearl St., New York, N. Y. Catalog No. 110, 52 pages, describing Weksler thermometers, hygrometers, psychrometers, hydrometers. Describes many different types of thermometers including straight stem and side angle industrial and reclining types, long-stem thermometers for specific uses, and other special types including thermometers for domestic use, bakers, packers, confectioners' types, etched stem solid glass thermometers including a large number of so-called A.S.T.M. thermometers. An extensive tabulation of hydrometers and hydrometer accessories is given.

LEEDS & NORTHRUP CO., 4934 Stenton Ave., Philadelphia, Pa. Catalog E-50B(3), 24 pages, "Type K Potentiometers and Accessories," describing and listing the two Type K Potentiometers, K-1 and K-2, particularly the latter because of its three ranges, convenient controls, coverings for all electric conducting parts and because it is standardizable without moving range switch or changing potentiometric setting. Covers galvanometers and other accessories suited for use with these instruments. Illustrates the thermionic amplifier which adapts potentiometers to measurements in high-resistance circuits, such as those for pH measurements using the glass electrode.

LANCASTER IRON WORKS, INC., Lancaster, Pa. Bulletin Seventy, 15 pages, entitled "Lancaster Mixers." Introduces the "Lancaster" Scientific Counter-Current Rapid Batch Mixing System, and describes various "Lancaster" Mixers and their value to such industries as the ceramic, refractory, glass and vitreous enamel, foundry, welding rod, chemical and concrete, etc. Also, Supplements Seventy-A, B, and C, describing mixers of various capacities, giving complete specifications and dimensional diagrams. Supplement D covers units recommended for smaller commercial capacities and for laboratory and research work.

"THE METAL ANALYST"—published by Adolph I. Buehler, manufacturer of metallurgical apparatus and distributor of optical instruments, 228 N. La Salle St., Chicago, Ill. 72 pages are devoted to detailed descriptions, illustrations, and information on microscopes, metallographs, specimen polishers, cutting and shaping devices, hardness testers, spectrographic equipment, etc., and there is an 18-page bibliography of technical publications, including books, pamphlets, and selected papers, articles, etc. There is also a detailed alphabetical index. The publication has a plastic binding with special covers.

Materials of Construction

RECENTLY PUBLISHED is the fifth edition of the book on "Materials of Construction—Their Manufacture and Properties" first prepared by the late Prof. A. P. Mills, Cornell University, with later editions edited by the late Prof. H. W. Hayward, M.I.T. The most recent edition was edited by Dr. L. F. Rader, Associate Professor of Civil Engineering, Polytechnic Institute of Brooklyn, an active A.S.T.M. member. Doctor Rader points out that the original purpose—to provide a textbook covering the manufacture, properties, and uses of the more common materials of engineering construction—is still retained.

Fundamental properties of materials are treated and test methods and requirements of metals in service are described. More space is devoted to metallography and the "constitution" of metals. The work on concrete, its chemistry, and physical properties, has been rewritten to give latest theories and modern information.

Quarry and mill practice for building stone, structural clay products, and glass building blocks are discussed. A chapter on timber includes considerable new data. There is a new chapter on bituminous materials. Another major change is the new section on organic materials covering protective coatings and organic plastics, written by Dr. W. H. Gardner.

The 564-page book, with a detailed index, is divided into eight sections consisting of some 25 chapters. These sections cover metals; cementing materials; concrete and stone; brick, clay products, refractory and heat-insulating materials; timber; bituminous materials; and organic materials. Each chapter includes a number of pertinent questions, of service in connection with classroom work, as well as a list of references for sources of information.

Of particular interest from the standpoint of A.S.T.M. is the wide use of material from Society technical publications, especially various specifications and test methods. This undoubtedly reflects Doctor Rader's close familiarity with the work of the Society and recognition of the value and authoritativeness of the information on properties of materials incorporated in A.S.T.M. standards. Copies of this publication can be obtained from John Wiley & Sons, Inc., New York City, at $4.00 in cloth binding.

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